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SCHOOL SCIENCE AND MATHEMATICS

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Science bows to no man, not even to the "hundred great books" of the past. Yes, science is an iconoclast, a disturber of faiths and dreams, a challenger of nostalgia. But science is a product of man, and science changes significant parts of man's environment faster than does raw nature. Science creates new problems important in the lives of all the people. The science core in liberal education must provide an understanding of these changes and problems lest we perish.—A. J. CARLSON.

CONTENTS FOR JUNE, 1946

SCHOOL SCIENCE
AND
MATHEMATICS

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THE FOLKLORE OF CHEMISTRY

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There is a varied and extensive body of chemical knowledge utilized daily in a practical or empirical manner by many people who, in most instances, do not know the meaning of the term chemistry. These operations frequently utilize scientific principles to attain the desired result; in many cases their employment has anticipated the scientific explanation for the successful outcome of the operation.

Folklore has been defined as comprising the traditional customs, beliefs, tales or sayings, preserved unreflectively among a people (1). On the basis of this definition there exists a vast body of unrecognized chemical folklore as this paper will endeavor to record.

In searching for the beginnings of chemical folklore one meets with immediate difficulties. Chemical folklore is as old as the history of chemistry but it has no literature of its own. Some of the lore has been handed down orally or preserved over the course of years by traditional custom. Old cookbooks and household books, the latter so popular in Victorian days, have preserved some of the information. Old almanacs are a veritable treasure trove. Interspersed among the calendar dates, weather prognostications, astronomical, occult and other printed tidbits, one finds occasional hints or adages that utilize chemical or physical principles to lighten some household chore, preserve health or improve on some traditional but inefficient manner of accomplishing a task.

We pass over the household arts of canning, drying of foodstuffs, soap making, candle fabrication, lime burning, etc. These operations have been described in numerous journal articles. There are, however, a number of operations to which less attention has been directed.

One of the most interesting traditions involves a chemical phenomenon which until recently was not understood although its results were quite apparent and undesirable. Shakespeare mentions that "the little pitted speck in garnered fruit rotting slowly, slowly moulders all." Farmers and thrifty housewives have long known that one "specked" or spoiled fruit in a basket accelerates the rate of spoiling of the balance of the fruit and so for time immemorial it has been the custom to periodically sort stores of fruit and remove all specimens that showed signs of spoiling.

As a result of recent research it is known that the spoiling (really accelerated ripening) is due to ethylene gas which is given off by the rotting fruit. On a commercial scale the ripening of whole warehouses of fruit is now successfully carried out by the liberation of a small volume of ethylene gas in the atmosphere of the storage rooms (2).

It is claimed that over a century ago the Portuguese in the Azores had discovered that burning wood in their hot houses accelerated the ripening of pineapples. This resulted, as we now know, from the ethylene gas present in the wood smoke. According to a recent account the ripening of pineapples is at present accelerated by inserting pellets of calcium carbide into the heart of the pineapple plant. The pellets give off acetylene gas under the action of atmospheric moisture and this gas, acting similarly to ethylene, causes the plants to mature earlier (3).

It is a well known experiment in introductory general chemistry to expose calcium hydroxide (lime water) solution to the atmosphere to form a surface film of calcium carbonate (the so-called chemical ice). This same film forms over the surface of lime water when it is used for preserving eggs. One of the adages of the housewife is that this film of calcium carbonate should be broken to remove eggs as infrequently as possible. The basis of this caution is a sound one and is based upon the possibility that eventually the lime might be weakened by total conversion to calcium carbonate. So long as the skin of calcium carbonate is not disturbed the balance of the lime solution remains at its original concentration but each time the surface skin of calcium

carbonate is broken an additional volume of the lime solution is converted into calcium carbonate.

Baking soda has long been advocated as a means of smothering chimney fires. It does this by the evolution of carbon dioxide and steam upon being heated. Probably the modern apartment house dweller has little need for such advice but it is frequently encountered in old almanacs.

The farmer's wife, without any knowledge of specific gravity, is frequently to be found floating a potato the size of an egg in salt brine that is to be used for the curing of ham to determine if it is sufficiently concentrated.

The same farmer's wife is quite apt to place several pails of water in the vegetable cellar on a cold night to prevent the vegetables from freezing. This is an effective preventative of freezing but the physics underlying it doubtless never troubles her mind. The basis of the idea is that as the temperature falls to the freezing point the water liberates heat due to a change of state. In a well insulated cellar the heat often is quite sufficient to prevent freezing of the vegetables. During the process of converting 1 gram of water into ice 79.71 calories of heat are liberated.

In the admirable historical novel "Drums Along the Mohawk" by Walter D. Edmonds it is related how pans of water were placed between the empty pews of a church to draw the frost from the walls (4).

It has long been known in common parlance that salt melts ice. This explains nothing but the physical chemistry behind the phenomenon is extremely interesting. When salt is mixed with ice the mixture falls to a temperature of 15 to 20 degrees below zero centigrade and remains approximately at this temperature until the ice has been melted by the abstraction of heat from the surrounding medium. Thus the sprinkling of salt on ice in the winter time does not simply melt the ice but it does lower the melting point below the temperature of the surroundings and as a consequence melting of the ice is initiated (5). Of course scattering salt on dry hard ice on a cold day is not very effective. To secure best results the salt must be mixed with the ice. The opportune time to add the salt is when the ice is wet or a thaw is just starting. Then the process will operate very rapidly.

Plumbers universally believe that "hot water pipes" freeze much oftener than cold water pipes. There is a basis of fact to this belief. Hot water pipes are filled with water from which most

or all of the air has been removed by boiling. When the water freezes the ice is compact and exerts tremendous pressure on the walls of the pipe. Cold water pipes are filled with water which contains a varying amount of air in solution. When the water freezes the air is liberated and the resulting ice is much less compact than the ice formed from air free water. As a consequence the pressure exerted on the confining walls of the pipe is much less inasmuch as the air is compressible and dissipates some of the pressure which otherwise would be exerted on the walls of the pipe.

In preparing iced tea a spoon should be placed in the glass along with the ice cubes to prevent shattering of the glass when the hot tea is added. The metal spoon possesses a higher heat capacity than glass and lowers the temperature of the tea by abstracting heat from the surrounding liquid. This gives the glass a few seconds in which to adjust itself to the increase in temperature.

Turpentine has been employed for many years to loosen ground glass stoppers that have become "frozen" in bottles. The average person utilizing this oil does not stop to consider why it is more satisfactory than others, such as mineral oil or olive oil. But on examining tables of physical constants the answer is at once clear. Turpentine combines low viscosity with low surface tension. In other words it possesses a tendency to creep into minute cracks between surfaces due to capillary attraction in virtue of its low surface tension and combines this property with that of flowing readily due to its low viscosity. Any of the oil that is drawn away from the main body of oil by capillary attraction is at once replaced by fresh oil that rapidly flows in to take the place of that drawn away.

According to Shreve (6) the effectiveness of Bordeaux mixture in controlling the downy mildew of grape vines was probably discovered by accident. Beginning in the eighteenth century it was the custom to dust grapevines along travelled roads with a poisonous mixture of copper sulfate and lime to discourage theft. It was not, however, until 1883 that the effectiveness of the mixture as a fungicide was recognized.

Although not directly related to chemistry it is of interest to note that a greater number of instances of so-called superstition by native tribes have subsequently been shown to have a basis of fact.

Everyone probably recalls how the Pilgrims were instructed

by the Indians to add a small fish to each corn hill at planting time to propitiate the gods and insure a bountiful harvest.

J. Alexander reports (7) that the early British explorer Captain Speke found a superstition among the Congo natives that the coming of the tsetse fly was associated with the incidence of sleeping sickness. It was not until years later that the medical world took cognizance of the fact.

Sir Richard Burton reported (8) ——— ——— ——— "This, together with the fever produced by the mosquito-sting, is universally believed by the people; the traveler will receive the information *cum grano*." Medical science now knows that the natives were correct in ascribing the origin of malaria to infected mosquitoes.

Long before the action of protective colloids was understood cows' milk was modified for infant feeding by the addition of gelatin, gum, dextrinized starch, and Bavarian beer (of high dextrin content) (9). In the same manner the alchemists utilized the protective action of colloids when they prepared *aurum potabile* by reducing gold chloride solution in the presence of ethereal oils (10). The protective action of colloids was also utilized by the Chinese who employed glue in the preparation of "Chinese" or "India" ink and by the ancient Egyptians who employed straw in the manufacture of bricks (11).

The ancient Egyptians soaked seeds in mare's urine to increase their fertility. We now know that hormones present in the urine were responsible for the increase in germination and the modern agriculturist now employs pure manufactured hormones for the same purpose.

Additional items of chemical folklore are given in Table 1.

Not all chemical folklore is based upon fact. It is not true that gasoline contains water because a cold gasoline engine upon first starting "spits" water from the engine exhaust. The mnemonic "A pint's a pound, the world around" is not true if lead shot is measured. The ancients did not possess the secret of hardening copper as believed by many.

Doubtless some readers of this paper will recall the story of the painter who was interrogated as to the cause of a near disastrous fire in his workshop and his reply that he was boiling linseed oil because he had heard that a boiled oil produced a superior paint vehicle. The moral is that chemical folklore, like dynamite or a host of other chemical substances, must be handled with respect and a little understanding.

TABLE 1. MISCELLANEOUS ITEMS OF CHEMICAL FOLKLORE

Empirical Operation, Phenomenon or Adage	Modern Scientific Explanation
1. Sheep thyroids fed to morons by the Chinese centuries ago.	Cretinism is the result of thyroxine deficiency.
2. Specific gravity of urine tested in India B. C.	Diseases such as diabetes produce an abnormally high specific gravity.
3. "Nature abhors a vacuum"; prevailing belief of the Middle Ages.	The atmosphere possesses weight
4. Green wallpaper is poisonous.	Arsenical pigments are no longer employed in printing wall paper.
5. Smoke from a smoking wood fire contains much sulfur.	Wood consists mainly of cellulose and water. The visible portion of smoke consists principally of carbon and condensed steam.
6. The term "Kobalt" employed by the old Teutons to denote a goblin responsible for unnecessary mining of false copper ore.	Cobalt ores mistaken for copper ores. Metallic cobalt was not isolated until 1742.
7. Will-o'-the wisps; ignes fatui of the ancients.	Burning marsh gas (methane) derived from the decay of vegetable matter.
8. A pinch of baking soda added to peas will improve their color.	Under the action of alkali, chlorophyll (the green coloring of peas) hydrolyzes to form degradation products of a greater intensity of color.
9. Covering cut apples, etc., with water to prevent discoloration.	The water precludes oxygen from forming brown oxidation products as a result of enzyme action.
10. The discomfort due to fish bones stuck in the throat can be alleviated by sucking a lemon.	Although it is true that bone (principally calcium carbonate) is dissolved by acids the action is mainly due to reflex actions of the throat muscles induced by the tartness of the lemon.
11. Placing a silver knife in polluted water will sterilize it.	Although it is true that finely divided silver possesses antibacterial properties bulk silver will not sterilize water.

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THE QUIZ SECTION

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1. "Dry Ice" is frozen carbon dioxide. (T or F)
2. Steel is an alloy. (T or F)
3. All solids are more soluble with rise in temperature. (T or F)
4. The speed of sound increases with increase in humidity. (T or F)
5. If the earth rotated under a stationary atmosphere, there would be tremendous winds all the time, with greatest violence at the equator. (T or F)
6. The kangaroo has claws on its forelimbs. (T or F)
7. Associate the following properly: potassium nitrate, zinc sulphate, sodium biborate, magnesium sulphate, copper sulphate, blue vitriol, Epsom salts, borax, white vitriol, saltpeter.
8. The tongue of the cats is rough whereas the dogs have smooth tongues. (T or F)
9. What is the most abundant element in the earth's crust?
10. What is the most abundant element in the earth's atmosphere?
11. If 45 pounds of steel are required for 250 pins 3 inches long, how many pounds will be required for 112 pins 7 inches long?

ANSWERS TO THE QUIZ SECTION

1. T; 2. T; 3. F; 4. T; 5. T; 6. T; 7. potassium nitrate—saltpeter; zinc sulphate—white vitriol; sodium biborate—borax; magnesium sulphate—Epsom salts; copper sulphate—blue vitriol; 8. T; 9. Oxygen; 10. Nitrogen; 11. 47.04 pounds.

EXPERIENCES TO EXPLAIN THE SIPHON

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The siphon is a deceptive gadget. It looks so simple. It is simple—to make and to use. But it is a Machiavellian device to introduce into the science classroom.

More complicated devices having been disposed of quickly enough, pupils expect a brief explanation of what goes on inside a siphon. So it is with growing bewilderment that they listen to our glib verbalizations, which seem to contradict so much of what we have said before. At last some pupil, usually a boy, raises a question that throws everything into confusion. Our only recourse is a far-fetched analogy which stops argument but proves nothing.

What pupils need in place of wordy explanations is a series of carefully planned experiences that will take them directly to complete and proper understanding. Perhaps such a series is too much to ask for—this writer has never discovered one that meets all the requirements. But there are many experiences involving the siphon and these can be arranged in a series which, with all its gaps, may still be of use.

The first portion of this series of experiences is designed to give pupils an understanding of the relation of effective lengths of siphon legs to siphon flow. Too often, after a single hasty demonstration, pupils come to false or misleading conclusions regarding the factors which affect the siphon. The following experiences give a more complete picture.

Each team of pupils is given a length of rubber tubing and two equal glass jars. Following directions given on the blackboard in the form of diagrams, they place a jar full of water beside an empty one. The siphon is started and the pupils note the conditions that end siphon flow and the conditions that restore it. Figure 1A.

To eliminate a common misconception about the effect of relative level of the containers, pupils should be directed to set an empty jar on a book or low block. Pupils will see that water can sometimes be siphoned from one container to another on a slightly higher level. Figure 1B.

To conclude this portion of the series, the pupils are directed to leave one end of the siphon free while the other is submerged. By raising and lowering the free end, pupils learn that the level

of the liquids in the containers is not the true basis for predicting siphon action. Figure 1C.

Pupils are now ready to discuss siphon flow in terms of the effective lengths of the legs of a siphon. They can now appreciate what is meant by this term and they learn quickly how the measurements should be made.

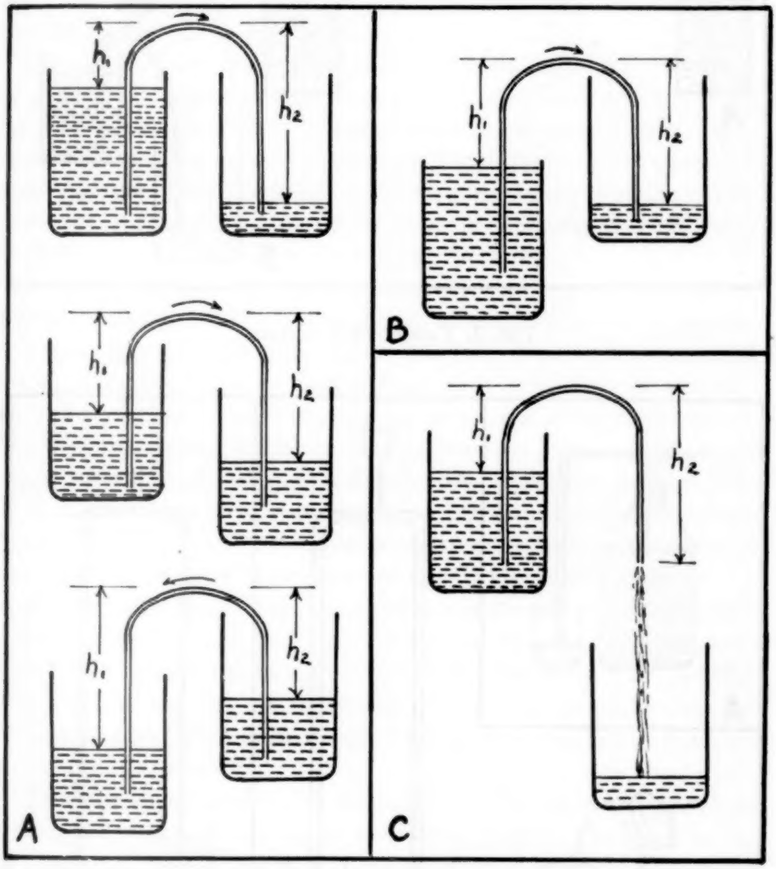

FIG. 1. Fundamental experiences with the siphon.

As a novelty, the teacher may introduce at this time the "Elongate Siphon." This is a long glass tube which is bent down at the ends and dipped into two vessels of differently colored liquids. The tube itself is filled for half its length with each liquid, the two being separated by an air bubble. Figure 2A.

The tube was first filled completely with one liquid by suck-

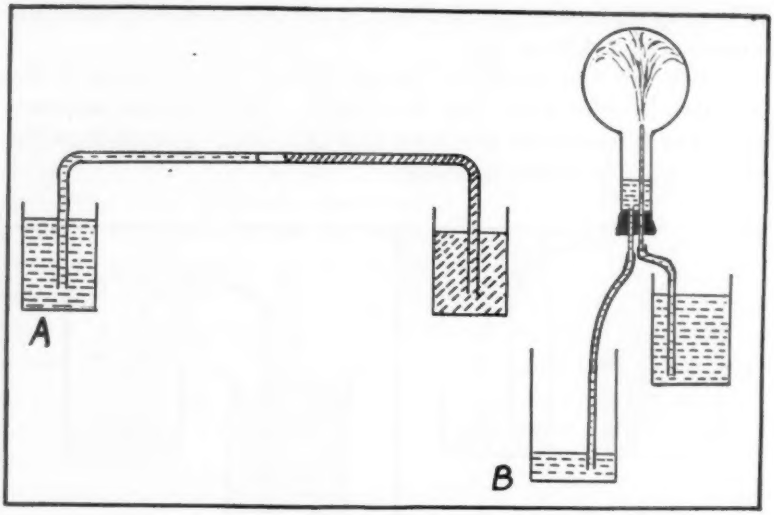

FIG. 2. Two novelty siphons.

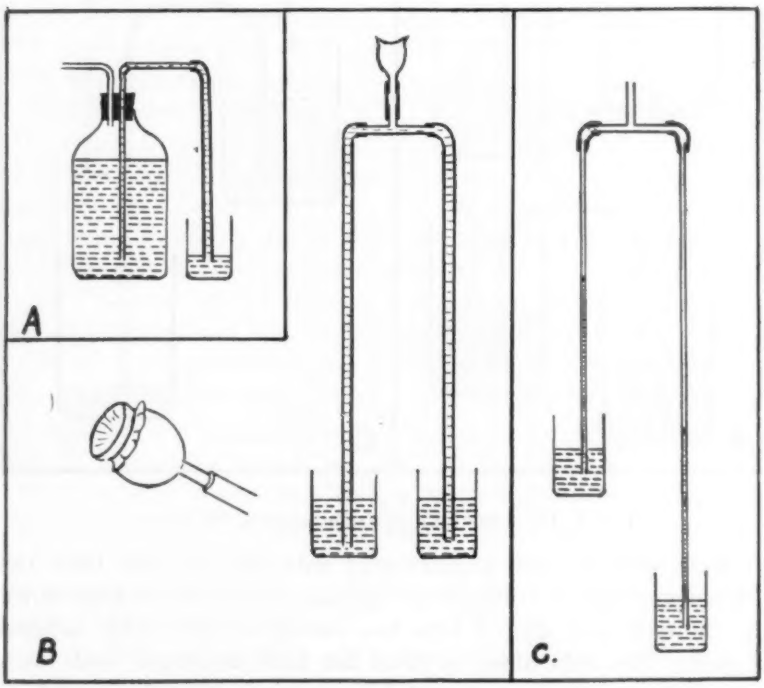

FIG. 3. Pressure relationships in the siphon.

ing. A bubble was then introduced by raising the free end slightly, after which this same end was dipped in the other vessel of liquid. Slight adjustment of the levels of the containers results in any desired distribution of the liquids in the tube.

Another novelty is the "Fountain in a Siphon." If this device is set in operation before the beginning of a class period it results in considerable interest because of its seeming defiance of the "law of gravity." Study of its operation may be postponed for later discussion. Figure 2B.

Pupils will have discovered that the rate of siphon flow varies. A quantitative experiment is now in order. Each team sets up its siphon with the effective legs adjusted to a certain ratio. They measure the time needed to move a given quantity of water for this and for other ratios. It is interesting to see whether they discover the need for some method of keeping the effective lengths constant and how they meet the need.

With the above described background of experiences established, it is time to study the pressure relationships in a siphon. Interestingly enough, this writer has found no text or manual which suggests showing that atmospheric pressure plays a role in siphon action. Conclusive proof is simple enough, however. One leg of a siphon is inserted through a two hole stopper into a large jug or bottle of water. Figure 3A. When the second hole is covered siphon flow soon stops, to be resumed when the hole is uncovered. If desired, additional pressure may be introduced into the jug to show that pressure affects the rate of flow.

Pupils must now discover that a low pressure exists in the upper portion of a siphon tube. A special siphon is constructed, using two rubber tubes connected at the top by a "T." To the third arm of the "T," some device for showing pressure changes is attached; a thistle tube covered with a thin rubber membrane is suitable. Figure 3B.

This siphon is sucked full of water and the ends are placed in vessels of water which are at the same height. The pressure in the upper region is shown to change when the height above the water levels is changed. One vessel is then raised so that flow begins and the low pressure is found to persist.

Pupils can now understand why water enters a siphon and why water does not run back out the shorter arm, especially if they have had previous experiences with the barometer, medicine droppers and similar devices. They must now try to understand why water runs out the longer arm even though atmos-

pheric pressure is more than adequate to hold water in the tube.

Another siphon is constructed, this time of two unequal lengths of glass tubing connected at the top to a glass "T." Figure 3C. The lower ends are placed in vessels of water, preferably colored, and suction is applied at the top. Pupils see readily that, although water rises equally in the two tubes, the difference in level of the columns remains the same.

It is at this point that the series of activities weakens and a little explanation becomes necessary. Pupils see that the shorter water column reaches the top first and that water spills over into the other side. Perhaps they can see that an equal amount runs out the bottom of the longer side. But they must be led to conclude that the longer arm cannot be kept full of water. Unfortunately, this device will not operate as a siphon because of trapped air, and we have not shown for certain why siphon flow can continue.

Nor has this writer found a method for showing why the rate of siphon flow depends upon the ratio of the effective length of siphon legs. By "reasoning," pupils may be made to conclude that water which spills over the top has a greater distance to fall if the two arms are much different in length. A discussion in terms of potential and kinetic energies is possible and advisable.

As a concluding exercise pupils may attempt to find the maximum height to which water can be siphoned. A long length of rubber tubing is stretched out on the floor and filled with water. The middle of it is raised up a stair well by means of a string. The tubing will soon collapse but the experience is in itself valuable because it proves again the existence of the low pressure in the top of a siphon. Perhaps other variations will suggest themselves.

A study of siphons would not be complete without demonstrations of the self-starting siphon, the intermittent siphon and the constant level siphon. These devices provide mental exercise for the better students.

OVER 21 BILLION PEOPLE

Number of people on the earth increased faster between 1900 and 1940 than in any other similar period. The annual per cent increase was 19% higher than between 1850 and 1900.

Should the present global population continue to increase at this rate, states Dr. Kingsley Davis of the Office of Population Research, Princeton University, the earth would hold over 21,000,000,000 people by 2240. In 1940 a little over 2,000,000,000 people were living on the earth.

CONSERVATION AND MATHEMATICS

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To many people the term "conservation" is generally understood to have a rather restricted meaning and suggests the conservation of natural resources such as forests, water and soil. In recent years, however, the definition of this important term has been extended to include man-made goods and human effort as well as all natural resources and it is now recognized that modern life is permeated with concepts and ideas associated with conservation. In fact, it has been well said that conservation is a "way of living" and this "way of living" has now assumed such importance that *Outdoor Life*, one of the great sporting magazines of the nation, is offering prizes of $5,000 for the best pledge of allegiance to the conservation of both human and natural resources.

While the effort to awaken the people of the United States to the pressing need of practicing conservation commands our deepest respect, it is questionable whether that desirable result can ever be effectively achieved through the routine repetition of a "made-to-order pledge." Is the loyalty of fourteen year old boys to the United States of America increased and deepened because they daily repeat the pledge of allegiance to the flag of their country? It is undoubtedly true that this diurnal exercise directs their attention to the importance of the flag but when the noble ideal of "one nation indivisible" becomes, as it frequently does, in the words of these potential patriots, "one nation invisible," there is indeed serious doubt as to what is really learned by means of this pledge-repeating experience.

If that is the method by which desirable learnings are achieved, let us then recommend to the million teachers in the public schools of America that in addition to hearing the pledge of allegiance they continue to listen as with slowly rising tempo their thirty million students draw upon their heavily burdened memories to make the following promise:

> I pledge myself to do my best to conserve the resources of the United States of America that they may be used intelligently and saved for generations yet unborn.

But these teachers know that the lessons of conservation are not learned through any such procedure and they also know that understandings related to this important topic cannot be

achieved through teaching it in isolation. The fact that conservation is a "way of living" means that it permeates all of life and we heartily agree with the judgment of the men who participated in the first Miami Workshop when they say:

The subject matter of this area is not a closed, closely organized body of knowledge comparable to conventional treatments of mathematics or history, and does not, therefore, lend itself readily to treatment through a sequence of specialized courses in the various school grades. On the contrary, every subject and interest in the school program has distinct and useful contributions to make to the understandings and attitudes that characterize the concepts of conservation education. Each subject should make its contribution and itself be vitalized by relationship to this vastly important field of individual and social concern.[1]

Whatever may have been the shortcomings of Adolph Hitler, he recognized the potential power of education in the development of social attitudes and, within the span of a few short years, there marched from the schools of Germany a generation of children who believed they belonged to the master race and dedicated to the idea that they were destined to become the rulers of the world. In their mathematics classes they dealt with no such peaceful ideas as the fact that 4 toothpicks and 3 toothpicks made 7 toothpicks. In an atmosphere permeated with the spirit of hate and echoing with the sounds of increasing military might they learned rather that four bombers added to the three already available made seven ready for service. The useful principles of mathematics were applied to materials which developed a mind set for war and, while we do not pay allegiance to these social values which gave direction to the schools of Germany, we do recognize the potential power of education in the building of those attitudes which gave shape and form to our democratic culture.

How then can mathematics be used to serve the interests of conservation education? The sources of materials related to this important outcome are very numerous and rich with quantitative data which provide almost unlimited opportunities for interesting and instructive problems. The time invested in the preparation and organization of these materials for class room use will pay big dividends in the quality of results achieved and we would propose that teachers of mathematics cooperate in the production and exchange of such materials. Various types of study guides may be used, some of which are presented in the following illustrations:

[1] Miami Workshop Committee, *A Program for Public School Education in Ohio*. Columbus, Ohio. 1944.

THE EROSION OF INCOME

It is quite probable that most teachers would consider that there was little if any relation between their income and the fact that soil erosion is destroying the fertility of thousands of productive acres in Ohio. In rural communities, however, the salary of a teacher is to a very large extent dependent on the financial condition of the farmers in that community and in this connection the data in the following table should be interesting:

ESTIMATE OF AVERAGE GROSS FARM INCOME IN OHIO FOR 1935

Counties with	Average Farm Income
1. Little or no erosion	$1,603
2. Moderate erosion	1,276
3. Moderate to severe erosion	986
4. Severe erosion to actual gullies	481

Assuming all of the data given in the table above to be valid, and using *only* these data, consider the following statements and in the space provided at the left mark each of them in accordance with the following instructions:

T if the statement is validated by the data in the table.
U if the data in the table are insufficient to determine either the truth or falsity of the statement.
F if the statement is denied by the data in the table.

____ 1. The estimated average income from a farm with only moderate erosion is $986.

____ 2. If the total income from a farm for 1935 is $480 the fertility of the farm has been seriously affected by very severe erosion.

____ 3. The average farm income in counties with little or no erosion is approximately 25% greater than the average farm income in counties with moderate erosion.

____ 4. The average income for 1938 from a farm with little or no erosion will be approximately $1,600.

____ 5. The income of farmer *X* living in a county which has actual gullies caused by erosion is approximately $500 less than the income of farmer *Y* who lives in a county with moderate to severe erosion.

____ 6. As the erosion of farm soil increases the estimated average income from the farm decreases.

____ 7. The agricultural methods used on farms with little erosion are more modern than those used on farms with severe erosion.

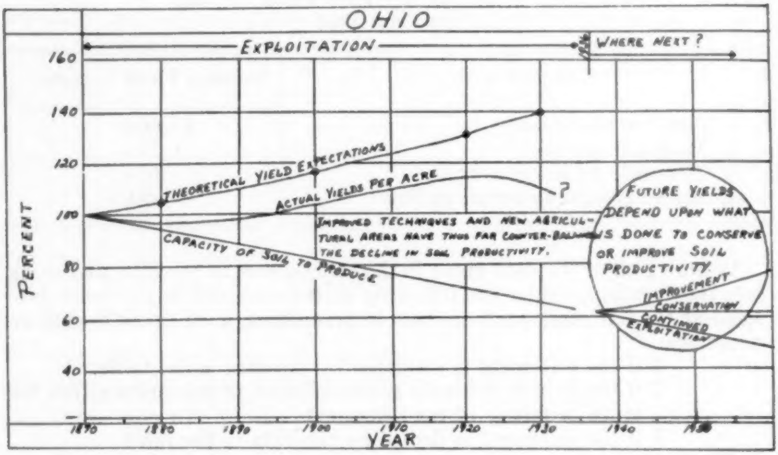
____ 8. If a farmer moves from a county with very severe erosion to a county with only moderate erosion his income will be increased by approximately $800.

____ 9. If the income from a farm decreases from year to year the erosion of the farm soil is increasing.

____ 10. The average salary of teachers in counties with moderate erosion is approximately 50% less than the average salary of teachers in counties with very severe erosion.

THE EXPLOITATION OF SOIL

Each year the farmer is confronted with the problem of obtaining larger yields from his farm. One of the important things he must consider in connection with this problem is the capacity of the soil to produce. The following graph shows in pictorial form for the state of Ohio the relations between the theoretical yield expectations, the actual yields, and the capacity of the soil to produce.



The statements which follow are interpretations which have been made of data in this graph. Assuming all of the data given in the graph to be valid, and using *only* these data, carefully consider each statement and in the space provided at the left mark it in accordance with the following instructions:

T if the statement is validated by the data in the graph.
U if the data in the graph are insufficient to determine either the truth or falsity of the statement.
F if the statement is denied by the data in the graph.

____ 1. Improved farm practices in Ohio since 1870 should have resulted in 40 to 60 percent higher yields per acre.

____ 2. The increase in yield from 1870 to 1930 in Ohio was less than 15 percent.

____ 3. The capacity of the soil to produce in 1870 in Ohio was 90 percent.

. . . .

____ 8. In Ohio the capacity of the soil to produce has been steadily declining.

. . . .

____ 13. The actual yield per acre in Ohio in 1920 was approximately 70 percent.

. . . .

____ 16. The theoretical yield in Ohio in 1880 was the same as for 1900.

. . . .

____ 20. In Ohio the actual yields will continue to decrease until 1950 and then will slowly increase.

In the space below, write any additional statements concerning conservation which you think are supported by the data in the graph.

Leaves Have Value

We often see the leaves which have dropped from trees being burned. This is waste. The 1928 Agricultural Year Book gives an analysis of a ton of leaf litter as follows; ammonia, 19.1 pounds; phosphoric acid, 2.8 pounds and potash 3.9 pounds. At this rate the leaves on an acre of ground would, at the 1928 prices, be valued at $43.93. This article also reports that a farmer, raking the leaves from an acre of oak woods, on to an acre of cropland increased his earnings during the next three years by the increased yield of corn and cotton of $16.15 over a similar acre not treated. Children can conserve by making compost piles.

Assuming all of the data given in the paragraph above to be valid, and using *only* these data, consider the following statements and in the space provided at the left mark each of them in accordance with the following instructions:

T if the statement is validated by the data given above.
U if the data above are insufficient to determine either the truth or falsity of the statement.
F if the statement is denied by the data given above.

____ 1. The value of the leaves that fall to the ground each year from the 3,707,958 acres of forests in Ohio is approximately $163,000,-000.*

____ 2. There is about seven times as much phosphoric acid in leaves as there is ammonia.*

____ 3. The ammonia in the leaves is worth more than the potash.

____ 4. Leaves will help the soil to yield more corn and cotton.

____ 5. Leaves will help the soil to yield more potatoes.

____ 6. Oak leaves are more valuable to land used in raising corn and cotton than other kinds of leaves.

. . . .

____ 17. Leaves are worth more now than they were in 1928.

____ 18. Twenty tons of leaf litter contains 382 pounds of ammonia.*

____ 19. Leaves from ash trees contain more potash than leaves from hickory trees.

In each of the preceding study guides interesting data related to conservation are provided and the student is given directed experience in the interpretation of these data. One very fruitful source of securing such statements as those used is to present the students with the data and ask them to draw any conclusions

* On the guide-sheets prepared for student use sufficient space is provided after each question for the student to show his work in solving the problem.

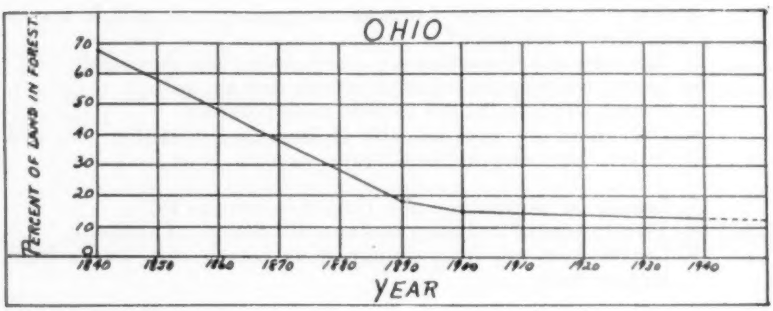
which in their judgment are supported by the data. This kind of practice is illustrated in the following study guide by means of which the teacher secures a variety of statements expressed in the language of the students. Many of these will undoubtedly be awkward and even ambiguous. Needed refinements can be made by the teacher and a study guide combining the thinking of the individual students can be prepared for the consideration of all of them.

The Decrease of Timberland in Ohio

In an article in the *Columbus Dispatch* of January 28, 1946, Chief U. S. Forester, Lyle F. Watts cited some interesting data in his annual report on the condition of the country's forests.

In making his point that the nation's timber supply from private lands is dwindling at a rapid rate, he noted that Pennsylvania, once the leading source of supply, has dropped to one percent of the total for the United States. In Virginia, lumber output has declined to one-half of the 1910 production, and the output of lumber in the lake states, which formerly produced 8,500,000,000 board feet annually, did not get above 1,250,000,000 board feet under wartime pressure.

These data suggest that the timber supply is dwindling. The following graph, when interpreted properly, provide interesting data concerning the forest land in Ohio from 1840 to 1940:



In the space provided below* write at least five conclusions that you believe to be supported by the data in the graph. An example follows:

> The percent of forest land in Ohio decreased steadily from 1840 to 1890.

* An extra sheet of paper should be attached to the student's study guide to provide sufficient space for his statements.

Materials related to conservation may also be used as a source of data from which many interesting and fruitful exercises may be developed. While the problems in the study guides which follow are comparable to those given in any text, they are illustrative of ways in which conservation materials can be used, and in any locality it is possible for teachers to secure data related to the community and to develop problems of vital concern to the student.

Running Water Must Walk

Soil erosion is the loss of top soil through the destructive action of wind and water. It is costing the United States more than $400,000,000 a year. In many areas of the United States wind is the destructive agent. In Ohio it is water, running rushing water, that is steadily destroying the fertility of thousands of fertile acres. It must be made to "walk" if we would save the productive power of our farms. How can this be done? One important principle that must be recognized in the study of this problem is that:

"The transporting or carrying power of water varies approximately as the sixth power of its velocity."

1. Using T to represent the transporting power of the water and V to represent its velocity, express this relationship as a formula.*
2. If the velocity of the water is doubled, what is the effect on its carrying power?
3. Compare the carrying power of two streams whose respective velocities, are 6 miles per hour and 18 miles per hour.
4. If the carrying power of one stream is six times that of another stream, what is the ratio of the respective velocities of the two streams?
5. In the first great Johnstown flood the transporting power of the water was sufficiently great to carry a heavy steel railroad locomotive along the surface of the water. As the flood receded and the velocity of the water became one-third as great as it was at flood peak, how was its carrying power affected?

....

16. Draw a graph showing the relation between the carrying power of water and its velocity.

Follow the Curvature of the Land

Straight furrows which all to frequently run up and down the hill are inviting pathways for rushing water which carries away the rich top soil including seed and fertilizer. "Plowing on the contour" has developed as a means of preventing this dreadful waste. Furrows which follow the curvature of the land tend to

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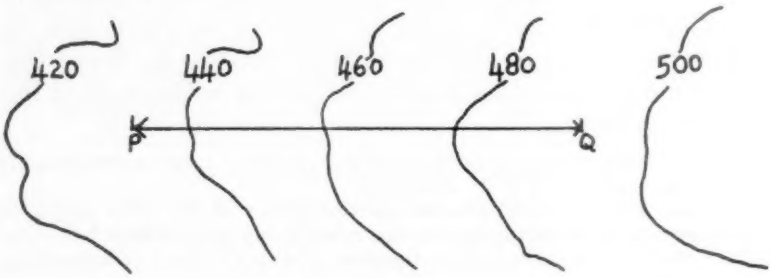
* On the guide-sheets prepared for student use sufficient space is provided after each question for the student to show his work in solving the problem.

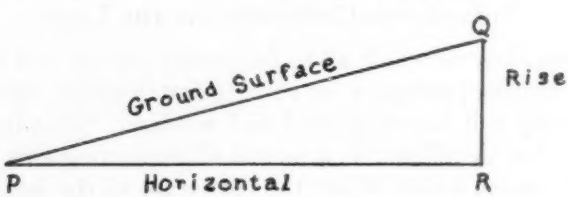
hold the rain where it falls, thus permitting it to be used effectively for the watering of growing crops. Contour cultivation has definitely helped to control erosion and has increased the yield to at least 20 % over straight row cultivation.

The laying out of contour guide lines on any slope is an excellent field exercise for any mathematics class and a simple method for doing this is clearly explained in *Leveling the Land*, a two-page bulletin written by William C. Pryor and published by Friends of the Land, 1 South Fourth Street, Columbus, 15, Ohio. By using this method the members of one mathematics class laid out contour lines on a neighboring hill and then prepared a map of this section. The contour lines on a small portion of this map are shown in the following diagram, where P and Q are points on the hill.



In reading this map you should be able to answer such questions as the following. Solve each of them and show your work in the space provided.*

1. What is the elevation of the point P?
2. What is the elevation of the point Q?
3. What is the difference in elevation of the points P and Q?
4. The length of the line PQ on the map is the horizontal distance covered in going from P to Q on the incline. If the scale of the map is 1:600 what is this horizontal distance?
5. In the following diagram PR represents the horizontal distance covered in going from P to Q along the surface of the hill while QR represents the difference in elevation between the points P and Q. What then is the slope of the hill? Express this as a ratio and as a percent.



* On the guide-sheets prepared for student use sufficient space is provided after each question for the student to show his work in solving the problem.

Floods Rise As Timber Falls

All of us who live in Ohio realize only too well that frequent floods are responsible for serious property loss in certain sections of the state. In an article in the *Columbus Citizen* of March 30, 1945, Mr. Daniel M. Kidney quotes from the records of the Census and Weather Bureaus in Washington to show that man and not nature is responsible for these devastating floods. He presents data which show that during the last 50 years the timber lands of Ohio have been steadily cut while the rainfall in the Ohio River Valley is less today than it was in 1890. He draws the interesting conclusion that:

> "Floods have mounted because wooded hills no longer exist to act as natural reservoirs."

Pertinent to this point is the following quotation from a recent pamphlet entitled *Bring Back the Forests*, published by the American Legion, Department of Ohio, in July, 1945:

> When Ohio was first opened for settlement in 1788 about 95 percent of the state area of 26,318,080 acres was covered by forests. . . . Today, the story is different. Only 3,707,958 acres are now in forest, and of this, only 986,640 acres have any present commercial value as a source of timber. Of the 3,707,958 acres of land now covered with forests, only 10 percent is in a high state of productivity; an additional 18 percent is in a fair condition and can yield reasonably good returns; the remaining land is of little economical value.

Using the data given in the preceding quotation consider each of the following problems. Solve each of them and show your work in the space provided.*

1. How many acres in the state of Ohio were covered by forests in 1788?
2. What percentage of the land in Ohio was covered by forests in 1945?
3. Between 1788 and 1945 how many acres of forests had been cleared?
4. Of the land now covered with forests, how many acres are at the present time "in a high state of productivity" and how many acres are "in a fair condition"?
5. What percentage of the land now covered by forests is "of little economic value"?
6. In gullied land a tree is usually planted in a plot 4 feet square. Under these conditions how many trees would be needed to cover an acre of ground?
7. It is estimated that there are 2,000,000 acres of land in Ohio which the persistent forces of erosion have made impractical for farming but every acre of this land can be transformed into a productive forest tract. If each tree is planted in a plot 6 feet square, how many trees would be needed to reforest it?
8. If the number of trees needed to reforest an acre of ground that is eroded but not gullied is 1210, how many square feet are allowed for each tree?
9. If there are approximately 1,000,000 acres of gullied land in Ohio, how many trees would be needed to reforest it?

. . . .

20. If only 6,000,000 nursery trees are available each year how many acres of badly gullied land can be reforested during that period of time?

Garbage is Valuable

In Indianapolis, Indiana, a city of 387,000 people, the garbage trucks collect and transport 30,000 tons of garbage to a reduction plant annually. From the 30,000 tons of garbage, the annual yield in grease totals 1,750,000 pounds. The grease is sold for $125,000 all of which is used to help finance the operation of the municipal government. This $125,000 is equal to 2% of the tax levy. There is an additional income from the sale of the "rough" tankage that remains in the percolator top after the process of removing grease. The city realizes $20,000 yearly from this source sold as stockfood and an additional $15,000 from fertilizers from this rough tankage. A city like Chicago, with a population of 3,397,000 spends $1,000,000 a year to destroy its garbage.

Assuming all of the data given above to be valid, and using *only* these data, consider the following problems. Solve each of them and show your work in the space provided.*

____ 1. What is the average number of pounds of grease obtained from a ton of garbage?

____ 2. How much money does the city of Indianapolis derive by its tax levy?

____ 3. How many tons of grease are extracted from the garbage in Indianapolis each year?

____ 4. How many pounds of grease are extracted from the garbage each year for each person living in Indianapolis?

____ 5. What is the total annual income for Indianapolis from its garbage?

____ 6. If the people of Chicago installed a reduction plant, how much money should they expect from their garbage each year?

. . . .

____ 17. What is the value of a ton of garbage?

____ 18. Assuming that 80 million people in the United States live in cities large enough to have a garbage reduction plant, (a) how much garbage would there be for these plants each year, and (b) what would be the annual income from these plants?

Write a brief statement explaining why you think cities should conserve their garbage and discuss the responsibilities of the average citizen in connection with this important problem.

Through the intelligent use of such teaching materials, followed by thoughtful and well directed discussion, the student should become increasingly sensitive to the meaning and importance of conservation. His attention will be focussed on those

* On the guide-sheets prepared for student use sufficient space is provided after each question for the student to show his work in solving the problem.

cultural practices which permit of extravagant waste and extensive destruction. He will learn that there is indeed a limit to the extent of our natural resources and he can be led to recognize that in reality the practice of conservation means the wisest and most effective use of these resources for the best interests of all the people.

Let us again emphasize the fact that the suggestive materials included in this article are only illustrative of ways in which the mathematics classroom may be used as a channel for the development of important cultural concepts. The alert and creative teacher should have no difficulty in preparing study guides suited to his purpose for there is a vast source of free and low cost materials available. Limitations of space make an extensive bibliography undesirable but the following selected references should be helpful:

BIBLIOGRAPHY

1. *Ohio, An Empire Within an Empire.* Published by the Ohio Development and Publicity Commission, 211 Wyandotte Building, Columbus, Ohio. February, 1944. 212 pp.
   It presents in factual form the pertinent data of the many resources and facilities of the State of Ohio. It is a storehouse of material that can be utilized by teachers of mathematics.
2. *The Teacher Looks at Conservation.* The Ohio Division of Conservation and Natural Resources, Columbus, Ohio. 1940. Second Edition 1942. 64 pp. 25 cents.
   It discusses the various aspects of conservation education as related to health, game and wildlife, soil, forests, water, and many other subjects of importance. It also contains some data that can be utilized by teachers of mathematics as well as a bibliography of more than 150 reference books; suggested reading materials for public library; periodicals; source materials for conservation education; list of bibliographies; source materials for conservation education agencies, federal, state, and private.
3. *Conservation for Tomorrow's America.* The Ohio Division of Conservation and Natural Resources, Columbus, Ohio. 1942. Second printing April, 1943. 144 pp. 50 cents.
   Contains some of the information contained in *The Teacher Looks at Conservation*, and much more with a wide treatment of conservation. It contains many ideas on conservation adaptable to classroom work, including mathematical data.
4. *Our Heritage, The Soil.* Bulletin 175 Agricultural Extension Service. The Ohio State University, Columbus, Ohio. Revised June, 1941. 20 pp. Free.
   Tells the story of what is happening to the soils of Ohio farms. Contains some line graphs, bar graphs, tables, and other data.
5. *Bring Back the Forests.* Sponsored by the American Legion Department of Ohio. 14 pp. Free.
   It states facts about the forests and forest products of Ohio and includes data suitable for a mathematics class.

This limited bibliography is illustrative of the various types of materials which are available, ranging all the way from rather elaborate books to special bulletins and pamphlets and a more extensive bibliography can be secured from the authors on request. A useful method for locating free and low cost materials is to secure from various government agencies their price list of publications. A card addressed to The Superintendent of Documents, Washington, D. C., asking for the list of available publications related to conservation, will also yield fruitful results.

SPENCER DARK FIELD QUEBEC COLONY COUNTER

The new improved design of the Spencer Dark Field Quebec Colony Counter is immediately apparent. Styled to conform with modern laboratory instruments, cool to operate, it is sturdily built of sheet steel. The front surface is inclined at an angle found to be most convenient to the average technician. An auxiliary tilting base can, however, be supplied when there is an individual preference for further adjustment. The scientifically designed reflector provides illumination, free from glare, uniform over the entire field and adequately bright to reveal and distinguish small colonies from other structures. Great emphasis has been laid on correct illumination to facilitate counting and to reduce fatigue.

The 4½" lens mounted on a sliding rod for focusing purposes has the standard 1.5× magnication specified by the American Public Health Association. It is so positioned that errors from parallax are avoided. If required, additional magnifications can be provided by the addition of an auxiliary lens. When not in use the lens and mount may be pushed down and out of the way.

Wolffhiegel, Steward and Jeffers guide plates are available. Centering screws are provided so that a petri dish may be positioned when circular ruled plates are used.

NEW AMPHIBIOUS VEHICLE

An amphibious vehicle, that is neither a boat on wheels nor a waterproofed truck but was designed from the ground up for its special job, is covered by U. S. patents 2,397,791 and 2,397,792, just issued here to two Detroit inventors, C. F. Kramer and F. G. Kerby, assignors to the Ford Motor Company. While it was avowedly developed for military purposes, it should be useful to ranchers, foresters, engineer and others who have to traverse wild country where bridges are scarce.

The vehicle has a body (or hull) shaped like a square ended, flat-bottomed boat, with sides recessed for the four wheels. The engine compartment, forward, is accessible through a double hatch; forward of this is a smaller hatch that admits air to the radiator during land operation but is shut when the vehicle enters the water. Cooling air is then drawn through ducts opening into the cockpit. A propeller and rudder make navigation possible.

Since the vehicle has some resemblance to the Army's famous "duck," except that it is smaller and more compact, it might well be nicknamed the "duckling."

BIRDING IN THE FLORIDA KEYS

HOWARD F. WRIGHT
Shortridge High School, Indianapolis, Indiana

Collectors and hobbyists of all kinds reserve special niches in their esteem for the rare and unusual. When the rare object is also beautiful, the hobbyist is sure to interest others with it, whether they are specialists or the uninitiated. Bird lovers usually cannot display their "finds" but must depend on telling others where they may be seen. My purpose in preparing this article is not merely to tell about "my trip," but more to urge others interested in birds and their preservation to take similar tours. If we observe first-hand some of the projects worthy of our support and encouragement, we will be that much more convincing as teachers and counselors.

This last Christmas vacation, with gas rationing ended, my wife and I decided to make a long-delayed trip to that bit of sub-tropical United States—southern Florida. To be sure, we did not begin to see all there is to see in such a short time, but we saw enough to whet our desire to spend other vacations there. Even the many Indian names of places in this region hold a special interest. Perhaps you have heard of Lake Okeechobee, but did you know that it is second in size only to Lake Michigan among the lakes entirely within the borders of the United States? But aside from mere size, it is of much interest to students of ornithology for its abundance of bird life. During February and March regular tours of the Okeechobee-Kissimmee region are conducted by members of the Audubon Society staff. And did you ever talk to anyone who has traveled along the Tamiami Trail who did not remark about the abundance of bird life to be seen there, or for that matter, can you think of many who have taken that trip who didn't do so expressly to see the birds?

While these places hold an interest that few others can approach, I want to tell of still another. Long before we began our trip we made arrangements with the National Audubon Society to spend a day with the warden whose job it is to protect the avian population of 300,000 acres of that portion of the Gulf of Mexico known as Florida Bay. This vast shallow body of water is dotted with numerous mangrove-covered islands, which you are quietly but insistently reminded are keys. At a distance these keys appear to be covered with sand, but closer inspection reveals that this "sand" is but broken bits of shells which ce-

mentation may later convert to coquina. Between these keys the channels are usually so narrow and shallow that boats drawing more than two feet of water cannot navigate. The water of this shallow sea is various shades of turquoise and so clear that when the water is quiet all the varied life on the bottom is clearly visible. The natives insist that often hurricanes blow all the water out of this area.

The Society informed us that we would find our host for the day at Tavernier on the southern tip of Key Largo. Any native could inform us where we might find Warden Eifler and his boat, the "Spoonbill." Not only did this prove true, but we found him a most congenial host. His powerful boat, especially constructed for navigation of the shallow bay, and hence not capable of much speed, was fitted with bunks for overnight trips to the more remote parts of the sanctuary. While we were getting our lunches and other equipment stowed aboard, we couldn't help but stop occasionally to observe the many species of gulls and terns circling overhead or resting on the water. Every direction we looked we could see brown pelicans, either on the water eyeing us with that stern dignity of which only a pelican is capable, or flying overhead. How such an ungainly bird can achieve such ease of flight never ceases to be a marvel. There were also numerous cormorants and occasionally one of those masters of gliding, the man-o-war bird, or frigate-bird, would sail in on bent wing. These birds have an unmistakable silhouette with their strongly bent wings and long, forked tail. They have a greater expanse of wing for the size of the body than any other bird.

Standing on the pier, looking out over this turquoise sea, with the temperature around eighty degrees and a slight breeze blowing, I forgot for a moment that it was the twenty-seventh day of December and caught myself on the verge of asking Warden Eifler if he made these trips all winter long. On the way at last, Eifler said he thought he could show us a great white heron almost immediately. We rounded a prominence of the key, and there before us standing in the shallows was this pure-white bird, common enough here, but not found north of Daytona Beach. This bird is not to be confused with the better-known American Egret, the owner of the once-sought-after "aigrettes" for the millinery trade, for its legs are yellow instead of black, and it lacks these beautiful plumes. I thought we might approach close enough to get a picture, but he soon took to the air and disappeared out of sight over the trees.

A little later we were to learn to know other white-plumaged birds—the American and snowy egrets and the white phase of the little blue heron, all of these seen occasionally in Indiana, but here as common as little green herons back home. These we had to distinguish by size and the color of bills, legs and feet. As we would approach the keys they could easily be seen perching in the green foliage or feeding in the shallows. If they failed to notice our approach, Warden Eifler would sound an ear-splitting klaxon horn which he had rigged up on the boat. At this sound, the air above the key would be filled by these lovely birds. Of course, we also saw the dark phase of the little blue heron, as well as the equally numerous Louisiana herons, which are easily distinguished from the little blues by their pure-white bellies. There was also the Ward's heron, the Florida version of our great blue.

One of the interesting birds we saw which is not found north of the gulf coast was the reddish egret. Its method of fishing is not like that of any other member of the order. Whereas its relatives wait for prey to come within easy reach of their spear-like bills, the reddish egret pursues its prey. This makes for some lively running and dancing until the prey is overtaken. We saw this comical manoeuver repeated several times and it never failed to intrigue us.

Then Warden Eifler announced that we were soon to see the main attraction of this trip. The roseate spoonbill, once almost extinct, is now making a remarkable comeback in the Florida Bay region. This bird is one of the main reasons for Eifler's presence in this region. Under his protection the "pinks," as he calls them, are well on the way back to their former abundance. These beautiful birds are not the distinct reddish color of the flamingo. There is a long narrow patch of carmine-red along the upper edge of the folded wing, but most of the rest of the plumage is really pink. As we approached the key, Eifler told us he spotted some of them among the foliage. We focused our binoculars on the trees and after some time we were able to find one or two. He assured us that without glasses he had spotted at least a half-dozen. They had seen us, however, and long before we had approached as close as we had to the herons and egrets, they had taken to the air. As their pastel-pink bodies were outlined against the blue sky, we felt that this sight alone repaid us for the trip. Before the day was over, we were to see almost fifty of these exquisitely-colored birds, probably as many as were in

existence just a few years ago. In spite of the beauty of their plumage, these birds have a rather comical appearance when viewed at close range. The long bill is flattened and spatulate near the end, which gives the bird its name. In feeding, this bill is swung back and forth in a sweeping fashion. Mud and water are thus strained through the bill until a small fish or crustacean is found.

The spoonbills are so shy that, once disturbed on their nests, they generally will not return. Eifler understands this and will not allow anyone to disembark on any of these keys during the nesting season. To realize that this policy is justified one has only to remember that when he came about five years ago there were only three pairs of nesting birds.

Even though we had seen the rare and beautiful, there were other birds yet to be seen. We were shown the nests and adults of several ospreys, as well as a nest of the bald eagle. Old Baldy did not show himself until Eifler gave several blasts on his horn. Then he launched his majesty into the clear air and we had a good view of the white head and tail of our national bird. At one time we saw a number of frigate-birds perched in the trees and we were able to see the bright orange patch on the throat which they are able to dilate in the breeding season, much as the pouter pigeons do.

We return via the Inland Waterway, that remarkable narrow strip of water through which smaller boats can navigate from Key West to New York, and be on the open ocean for only about twenty miles. Once in this channel, Eifler asked Virginia if she wanted to play skipper. She jumped at the chance. As he settled back into a deck chair beside me, he said, "I think I'll write to the Audubon Society and ask to take one of these tours." I made some remark about the postman taking a hike on his day off, but secretly I was envious of his opportunity to see these sights every day.

Parents must grow with their children. It is too much to expect of the child to live as the wisdom and experience of the adult dictates. It should not be difficult for the adult to attune himself to the psychology of the child and guide it through the maze of conflicting emotions resulting from the impact of life upon the immature mind.

If children are to be good, using the term good in its broadest sense, it is necessary for the parents to grow with their children.—Jacob Panken.

UTILIZING PUPIL EXPERIENCES IN THEIR DISCOVERY OF MATHEMATICS*

PAUL TRUMP
University of Wisconsin, Madison, Wisconsin

There are two fundamental principles in learning which I believe you will be willing to accept as postulates for the purposes of our discussion. Other things being equal, a pupil's profit from a learning experience is in direct proportion to

1. The extent that his appropriate experience background is utilized.

2. The extent that his active participation is enlisted.

By experience background I mean information, concepts, attitudes, habits, understandings and interests which have been gleaned from the totality of all his experience, in and out of school. The *new* experience must be so planned as to grow naturally out of this background and to fit into its proper place. The more the pupil is able to bring to the new experience, the more he will take from it. The better the results of the *new* experience, are related and integrated with all his *former* experiences, the more certain we can be that the new results will become and remain a functioning part of his growing background.

By active participation I refer to a proper balance between mental, emotional and physical activity. This involves the desire of the pupil to meet a challenge, to satisfy a curiosity, to indulge in an interest or realize a personal goal. The activity must be so planned and directed as to utilize all avenues of approach to his mental processes. It must challenge his initiative and constructive contribution. It must develop in the pupil a confidence in his own ability to bridge the gap between old and new experiences. Whatever be the limits of his ability, his progress should approach those limits and should yield satisfaction as a personal achievement. It is common knowledge that the pupils in our classes seldom reach anything like a peak performance.

Our present curriculum in the secondary schools did not grow out of one planned with a conscious effort to achieve consistency with these postulates. In the development and growth of our mathematics curriculum, however, we have made considerable progress in this direction. As evidences, I should like to cite certain facts and trends during our present century. At the

* Read before the Chicago Men's Mathematics Club, February 15, 1946.

opening of the century Professor E. H. Moore, in his retiring address as president of the American Mathematical Society made certain recommendations for greater integration between science (physics in particular) and mathematics. We have seen increasing emphasis on teaching mathematics as a laboratory science. There has been a definite trend toward inductive presentation of subject matter in the teaching of albegra. This gives the pupil the chance to observe, compare and generalize. There is a gradual increase in the amount of so-called intuitive or experimental geometry taught in the Junior High School. Formulas as means of expressing: first rules, and then relationships, have received increasing emphasis. More and more the formula serves as the medium of approach to algebraic processes. Graphical representation as an added aid in describing relationships is a rather recent innovation. We have seen much emphasis in the literature on the objectives of critical thinking relational thinking, and the ability to interpret data. These are all outgrowths of attempts to achieve consistency with our opening assumptions. "Thinking objectives" have received increasing emphasis because of the conviction that they are not automatic outcomes of formalized routines of thinking as often practiced in the mathematics classroom. They must grow out of real pupil experiences in thinking. This emphasis ties in closely with the current emphasis on meanings in the teaching of arithmetic. You have found very much of value in the last two year books of the National Council of Teachers of Mathematics. The 17th: *A Source Book of Mathematical Applications* and the 18th: *Multi-Sensory Aids in the Teaching of Mathematics.*

These facts are significant. They show a trend toward consistency with our postulates of experience background and activity emphasis. They show a recognition of many of our basic difficulties due to the abstract character of mathematics as a science. The very strength and power of mathematics has been a stumbling block to us who attempt to teach it.

You have heard much on both sides concerning the issue of deferred arithmetic in the elementary grades. To me it boils down merely to this. We cannot say that formal mathematics is suitable for an *n* year old while a younger child must have only informal experiences. We *can* say that learning cannot profitably be formalized beyond the experience readiness of the pupil. It is high time we recognize this fact on all levels of instruction.

In order to capitalize upon pupil backgrounds and activities, some have promoted the "What shall we do today children?" approach. I shall not dwell upon the difficulties inherent in such extreme pupil planning procedures. The idea back of such procedures, however, has much merit. It reflects basically a realistic approach to problems of mathematics teaching.

An approach to this problem of realistic experience which has gained considerable favor is through the use of mathematical applications as aids to teaching. Too often, however, the application is restricted to use as a propaganda device. Propaganda for mathematics in the hands of an enthusiastic teacher has some merit. At least, for some, the enthusiasm may be contagious. However, a child may be convinced that mathematics helped immeasurably in winning the war that there is mathematics involved in building airplanes, that railroad rails are parallel, that snow flakes and other crystalline forms feature designs of complexity and symmetry, but he may still feel none of the impact of this knowledge upon his mental curiosity and initiative in factoring the difference of two squares or proving two triangles congruent.

Too often we confine the use of applications to the role of an exercise or drill in a learned technique. We then often have the cart before the horse. Carefully chosen applications are promising sources of problem situations of value as exploratory learning exercises. If the pupil brings to the problem a background of experience which enables him to exercise initiative in discovering a solution and is then led to the discovery of a mathematical principle, there is reality and vitality in his learning. It is not only something learned which is real and meaningful but also a significant experience in learning. We wish not only to impart information and skills. Our obligation is one of education and not mere training. Individuals must be able to adjust intelligently to problem situations and to assert confidence and initiative in their attack. They must be able to bring to bear the knowledge and skill they possess even though the situation be considerably changed from any experienced precedent. For many students on the secondary school and junior college levels there is reason to believe that their experiences in mathematics classrooms have actually been a negative influence on their confidence and initiative in meeting new problem situations involving unfamiliar elements.

I should like at this point to consider with you a few opinions

and suggestions for the organization and teaching of demonstrative geometry which seem to me to be consistent with the emphasis in our discussion. In the logical organization and emphasis on proof of our courses in geometry we meet what appears to be a definite obstacle. Consistency with out assumptions regarding experience background and activity seems even more difficult than in much of the work of algebra. We have increased the emphasis on originals and applications but we have difficulty in making the emphasis on demonstration pay off. We cannot long keep demonstrative geometry in the curriculum unless its teaching be directed specifically to the special purposes of teaching demonstration or logical proof.

Among these special purposes the learning of geometric facts and relationships are relatively unimportant. These theorems could be more effectively taught without complicating the issue with the necessity for formal proof. It is a rare child whose emotional acceptance of a theorem is affected by logical demonstration. We note also that practice in the routines of logical thinking in the geometry classroom seems to result in embarrassingly little change in behavior patterns outside the classroom.

The pupil brings to the course in demonstrative geometry much related background experience. He should have had intuitive and experimental contacts with angles and their measurement with lines, triangles, basic constructions, and with many of the basic relationships involved. He has had much contact in his out of school experience with geometric form and relationship. These out of school experiences are often of a spatial character. The child has lived and thought in terms of three dimensions and care must be exercised lest we too abruptly idealize these experiences and restrict them to a plane.

The pupil brings also certain limited backgrounds in logical implication. He has engaged in arguments and various kinds of reasoning. If we too rapidly formalize the demonstration procedures of geometry, we ignore the potential contributions of this background.

We might well begin the course with a laboratory study of some major problems of concern to the pupil. In this age of global consciousness and air transportation such problems might be concerned with locating the position of a point on a plane or spherical surface. I do not mean that this be merely a cursory or superficial treatment nor merely for propaganda purposes.

It might be his most promising opportunity to learn about latitude and longitude as earth coordinates. Much of the geometry the pupil has learned could be brought to bear. Some reasoning situations could be introduced informally. He is taught to visualize geometric relations in space. He sees how these spatial relations must first be studied in a plane. He is shown how the geometry he knows actually works. Some new basic concepts such as arc degree are introduced in a realistic fashion. He is learning something of value to him irrespective of its purposes for the further study of geometry.

The problem of critical thinking should then be introduced, not as a list of axioms or confused with a review of geometric facts but as an honest introduction based on his reasoning background. It should not be thought of as geometry at first but as a problem in saying what you mean and drawing implied conclusions. The nature of assumptions and definitions must not be confused with a concept of the obvious. The difference between reasoning intuitively from experiment or observation and reasoning logically should be made clear. He is going to be asked to play a new game and he deserves to know the rules. Start where he is and depend upon him for active cooperation in building firmly upon that basis.

After the purposes and something of the nature of critical thinking are made clear, the idea of using geometric relationships as the vehicle of thought is not difficult to promote. Geometry has many advantages in this role.

It would be desirable, if practicable, that the child be allowed to accept all geometric relations with which he is familiar as assumptions and proceed from there. Practical limitations of group procedure and time, however, dictate a *common* basis. There must be agreement as to what assumptions and definitions be accepted. It is foolish, however, both pedagogically and mathematically at this stage to insist on anything like a minimal list.

After the child learns what it means to prove something and after certain agreements have been reached on questions of convenience and form in presentation, I would adhere basically to certain principles.

It is often more valuable for a child to develop several alternative proofs for one theorem, than to be asked to master outlined book proofs of each of several theorems. We might in fact throughout the teaching of mathematics discover that if chil-

dren learned half as much twice as well they would realize eight times the educational value.

Before being asked to prove any theorem the child should thoroughly understand and emotionally accept it. Even the professionals work this way. Usually important mathematical results come via hunches and intuitive results. The patching up of the logical chain of implication follows.

The attempt to gain emotional acceptance should be by exploratory problems in which the child is led to desired conclusions of his own formulation. Here is the point at which learning situations adapted from applications have an important place.

At any stage in the development, if it seems desirable for the basic purpose to assume certain theorems, by all means add to the list of assumptions.

If a method of proof or analysis is needed it should be clearly developed in view of the purpose it will serve. It should be built upon the basic experience pattern of the pupil and constantly reassociated with experience patterns developed outside the geometry class room.

With such a basic organization of subject matter the role of pupil activity can be effectively brought to bear. He can be encouraged to develop initiative in discovering relationships and in proving them. There is little value in being able to give proofs of a large number of book theorems or even in doing a large number of classified originals. The value lies in the exercise of pupil initiative. The value of demonstration lies not so much in the finished product as in its production. Thought processes are too crucial a heritage of man to permit us to dare to try to groove them into previously digested diets. If the activities revolving around demonstration in geometry for a given pupil do not give play for his initiative and confidence in his attack, then its value for him is likely a negative one.

The use of the sound movie is a promising aid to the mathematics teacher in carrying out a program based on these recommendations. It appears that at present available films fall far short of realizing their potential contributions. They will always be teacher aids, not substitutes. However, the film can contribute in overcoming many of the practical difficulties involved in the approach to pupil discovery of mathematics through activity based on meaningful experience. Not propaganda films or films portraying a blackboard lecture but films which utilize actual problems met by the draftsman, the car-

penter, the mason, the machinist, the home decorator: to provide *learning* situations. A film might be effective in presenting problems, the pupil retains the responsibility for solutions. The pupil wants to know something of the why and how as well as the what and where of mathematical usages. In the same way, there is great promise in the use of all types of audio-visual aids in order to develop efficiency and effectiveness in carrying out the basic idea of discovery through supervised experience.

Mathematics study in the secondary schools must become something more than a training ground in the techniques, skills, and vocabulary of formal mathematics. Until we have carefully re-examined our objectives and teaching procedures we cannot hope to meet the challenge which is constantly confronting mathematics as an experience in general education. Until we can do this I do not believe we can be completely successful in meeting the increasing demands made upon us in the present world of science and technology even for the training aspects of mathematics. Whether our concern is that of the philosopher, the general educator, the mathematician or the scientist, I believe the problem is basically the same. The best solution for one will result in at least immeasurable improvement for all. Whether the pupils' interests and needs are college or non-college, vocational or non-vocational, professional or non-professional, mathematics can serve him. And at least for the major part of his high school course, I believe the specific type of experience mathematics can best provide is more a function of the pupil's past and present environment and ability than it is a function of his future plans and aspirations.

NEW AWARD TO BE CONFERRED BY ENGINEERING EDUCATORS

This year, for the first time, a new award of $1,000 will be given to the college or university teacher adjudged to have contributed most to the successful teaching of engineering students, it was announced by The Society for the Promotion of Engineering Education.

The prize, to be conferred annually, will be known as the George Westinghouse Award in Engineering Education. Established to commemorate the 100th anniversary of the birth of the famed inventor, the award has been made possible by the Westinghouse Educational Foundation.

In announcing the plan, Dr. Harry S. Rogers, President of the Society for the Promotion of Engineering Fducation and President of the Polytechnic Institute of Brooklyn, made clear that while there are no age limitations in making the award, "consideration will be given especially to the younger men who show by their past record evidence of continuing activity as superior teachers."

REPRODUCTIVE BIOLOGY

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As I sum up the known results of ten years' teaching, the vast gap between what I hoped to do and what I have done, is appalling. But here and there, there is a reason for satisfaction. For instance, teaching the biology of human reproduction in ninth grade general science has given a good return on the time and effort invested.

About four hundred boys and girls have been exposed to my efforts and among these only one case of premarital pregnancy has come to my attention. In this case the girl was over age when she came to me. She was married before the baby was born.

In the same schools I know definitely of four such pregnancies that occurred in cases that missed my efforts. In only two of these cases was the girl married before the baby was born. I feel that I have helped to head off some needless suffering.

The seventh and eighth grade boys and girls write the usual vulgarities on the toilet walls. This stops when they take general science.

The boys and girls help each other in class with the difficulties of anatomy of the reproductive system just as they do with the other systems. The intellectual difficulties are large enough—I give them more than many of them can learn—so that there seems to be no room left for any erotic responses. It is very gratifying to see a bright boy helping a dull girl to understand her own reproductive system and to see a bright girl helping a dull boy in the same way. The quality of the emotional atmosphere in which the study is conducted is one of the most gratifying results of my efforts.

I am teaching this subject matter on my own responsibility. I never asked permission of anyone nor looked to anyone for support. There was an obvious job to do and I was in a position to do it, so I did. At first I took some precautions against publicity but as the years have passed without adverse incident I feel that I am on firm ground

I could not have handled the subject if my own emotional background had not been fortunate. My parents have a high regard for truth. They told it. The stork was never tangled up in my emotions. I saw bulls and tom cats performing their essential functions when I was very young and I witnessed the

birth of kittens and calves. There was no question of good or bad but simply—this is the way it is.

In my own study of biology in high school I would like very much to have had as much information about human reproduction as about fish and frogs. It was not to be had. I remember how eagerly the encyclopedia was consulted for information which, for the most part, was not there. When I found myself in a position to do for others what had not been done for me I knew what to do.

I am genuinely anxious to give every assistance in helping people learn the very difficult art of living together in peace. A knowledge of reproductive biology seems to be a very important phase of this art. I am very anxious to reduce the tragic discord which is characteristic of so many families.

In my general science class the study of human reproduction is the last in a series of reproductive studies starting with flowering plants and including liverworts, mosses, ferns, earthworms and frogs. These organisms are not selected to make human reproduction clearer but because they are important for their own sakes. In a farming community plant reproduction is as important as animal reproduction but one helps very little in making the other clear. However we do develop a fairly good vocabulary before getting to the final case.

In each case the following equation is emphasized:

$$\text{sperm} + \text{egg} \rightarrow \text{zygote}.$$

In connection with each case we try to develop a curiosity as to the origin of the sperm and egg, how they get together and what becomes of the zygote. It is interesting to note that the entrance of the pollen tube into the micropyle—which I draw on the board—is the only item in the whole study which can be depended upon to produce a slight erotic response. This I ignore. An adolescent without erotic capacity is abnormal.

By the time we reach human reproduction enough vocabulary has been learned so that much of the work is review. The vocabulary includes testis, seminal vesicle, ovary, oviduct and copulation.

The study of each human organ system starts with a lecture-discussion. A tracing of the system is made as an outside assignment. This is labeled in class under supervision. Anatomy books and charts are used and the boys and girls help each other.

It is amazing and gratifying to see what serious business these

tracings are. Even the most indifferent students are anxious to keep up to date while we are doing organ systems.

The tracings of the reproductive systems show ovary, oviduct, uterus, vagina, hymen, clitoris and testis, vas deferens, seminal vesicle, urethra, penis and scrotum. The pupil is expected to know the function or importance of each part. They also learn the meaning of copulation, semen, fertilization, pregnancy, gestation period, birth, menstruation, sterile, sterilization, and masturbation. As far as I can discover the only one who is ever under any strain through all this is the teacher. For the class the erotic possibilities seem to be completely lost in the intellectual difficulties. This is born out in the written examinations where both boys and girls attribute to themselves organs which they do not have and arrangements which are completely novel.

Venereal disease is discussed later along with other diseases.

Throughout the study the emphasis is on biology. This seems to fill the bill at this age level. Obviously this effort does not yield a finished product. There is probably need for further study from a psychological and social point of view in the senior year but in this I have no experience worthy of a hearing.

A TEACHING AID FOR KINETIC MOLECULAR THEORY

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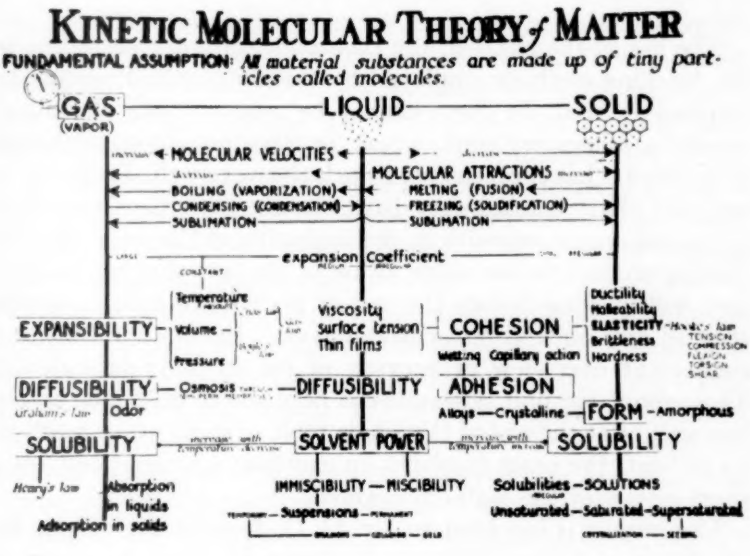
In every physical science course the student is expected to learn something about the kinetic molecular theory of matter. Generally more time and effort is put into this instruction in standard physics courses than in chemistry courses. In many physics texts a whole unit is devoted to the study of molecular behavior and the phenomena which can be explained on the basis of the kinetic molecular theory. Some physics texts touch upon the topic of molecular behavior in nearly every chapter on mechanics and heat.

Because some of these presentations of molecular behavior are scattered widely both in textbooks and courses, it is evident that it might be of help to the student to have some way of correlating the various molecular phenomena into a unified picture.

Perhaps even in separate units devoted entirely to molecular theory the student may not be able to relate the material studied at the beginning of the unit with that studied at the end of the unit.

In order to present a unified picture of the kinetic molecular theory and the laws and phenomena related to it, the author began by purchasing a blank white wall chart measuring 62 by 44 inches from a map and chart making concern. The chart was lettered as shown in the diagram, here reproduced in miniature,



and made suitable for hanging on a blank wall in the science classroom. In general, the concepts and properties to be emphasized most in teaching the theory are lettered with large letters in order to emphasize their importance. On the chart the three states of matter, solid, liquid, and gas and their interrelations are joined by horizontal lines. Phenomena and properties related mostly to solids are found immediately below the word SOLID on the right hand side of the chart. Phenomena and properties relating to the liquid and gaseous states of matter are found below each of them. Certain general characteristics related most often to both solids and liquids, or both liquids and gases were lettered between the two and connected to the solid, liquid, or gas "stems" by heavy black lines. The words SOLID, LIQUID, and GAS and the small diagrams asso-

ciated with each of them were lettered in blue, green, and red show card color respectively. All other lettering was done with black India ink.

Many problems arose in deciding what to include on the chart and where and how to place the words and phrases. In most cases a compromise was necessary. For example, gas molecules have a small amount of cohesion and adhesion, but in most elementary texts discussion of these phenomena is omitted. The chart is by no means complete and omissions were often made in order not to confuse the beginning student with too much detail.

The use of the chart in the classroom will vary according to the teaching methods employed by the instructor. It should be emphasized that the chart cannot be used in place of demonstrations, laboratory work, a text, or class discussions, although in practice it has supplemented the latter very well. Taken by itself, the chart teaches very little. In the classroom the chart will arouse some curiosity at the beginning of the year. The beginning student is also made aware of the fact that his vocabulary will increase before the end of his science course. At the start of any unit on molecular behavior, the chart furnishes a convenient over-view or preview of the work to be covered. Throughout the unit reference can be made to it. At the end of this unit or at the end of the whole topic of elementary mechanics or heat, the chart furnishes an excellent starting point for a short review of the material covered.

The author is indebted to Dr. G. O. Johnson and Capt. W. W. Strait of Culver Military Academy for their helpful suggestions in planning the chart and to Mrs. Kernohan for her patience in performing a splendid job of lettering.

2×2 FULL COLOR BIRD SLIDES AVAILABLE

The National Audubon Society announces a series of 2×2 full color slides, a new addition to the Audubon Film and Slide Library. Made from the bird paintings by Major Allan Brooks, the slides will be a valuable aid to teachers, leaders, and to camps, clubs, youth groups. Experience has shown that pictures of this type are superior to actual color photographs in teaching work as each bird is shown in exactly the correct position to reveal its characteristic field markings.

The slides, 150 in all, are available in seven sets of twenty each and one of ten. They will sell for $5.00 per set of twenty, $2.50 for the set of ten, or $35.00 for the eight sets. A listing of the various birds in each set may be secured by writing to the National Audubon Society, 1000 Fifth Avenue, New York 28, N. Y.

SOME WAR-TIME DEVELOPMENTS IN CHEMISTRY

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II. Inorganic Materials

One of the most epochal events of scientific history is the quantity separation of Uranium^{235} together with the large scale production of the transuranium elements, neptunium and plutonium. These goals were reached through the combined efforts of a large group of the world's most brilliant scientists including physicists, physical chemists, chemists, physicians, sociologists and engineers. Investigations were carried out in many laboratories and in such complete secrecy that many of the participants did not know the ultimate objectives. But the advent of the atomic bomb has created a profound impression upon human thought and its effects seem destined to influence the progress of civilization for generations to come.

A glance over the publications of recent years shows that the liberation of atomic energy was to be expected. Elements 93 and 94 had been reported previously[17] and their properties[18] were pretty well understood. U^{235} had been separated[19] in small quantities by Meitner and Hahn in 1936. In the President's address in 1940 at the Centenary Meeting of the American Chemical Society, Dr. S. C. Lind of University of Minnesota, discussed[20] the energy content and the available supply of U^{235} together with the possibilities of its use as a source of power. The fission of uranium atoms by neutron bombardment, producing two sets of particles, which differ in mass and energy content, was reported[21] as early as 1939 and the following year a successful chain reaction with uranium was shown to liberate a large amount of atomic energy. These preliminary steps were very important and were well known throughout the world of science. They indicate that much of the fundamental experimentation had been done. But they in no way detract from the

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[17] E. Fermi, *Nature* **133**, 898 (1934); Hahn and Meintner, *Naturwissenschaften* **23**, 37, 544 (1935), **24**, 158 (1936); *Ber* **69**B, 905 (1936); A. J. Dempster, *Nature* **138**, 120 (1936); Laurence L. Quill, *Chemical Reviews* **23**, 87 (Aug. 1938). Many other references might be given for this and the following.

[18] H. J. Walke, *Phil. Mag.* **21**, 262 (1936); A. V. Grosse, *Jour. Am. Chem. Soc.* **57**, 438, 440 (1935).

[19] Meitner and Hahn, *Naturwissenschaften* **24**, 159 (1936).

[20] S. C. Lind, *Science* **92**, 227 (Sept. 13, 1940).

[21] O. Haxel, *Zeit. Physik* **112**, 681 (1939).

splendid accomplishments of the Manhattan Project. When this undertaking was inaugurated much remained to be done. These initial steps were all taken with small amounts of material and quantity production was essential. The gathering of adequate quantities of material, the separation of the isotopes, the control of large masses of fissionable material, the safety and health of the workers, the sudden release of such enormous quantities of energy and many other problems remained to be solved. That the enterprise was carried out marks a new era in scientific endeavor, which is likely to dominate the thinking of mankind for many generations, in the scientific, social, political, humanitarian and commercial aspects of life. The adaptation of these tremendous new forces away from destruction and toward the work of peaceful pursuits is a problem of no mean magnitude which still remains to be solved.

Two new chemical elements have been added to our list: neptunium (Np, atomic number 93, atomic weight 239) and plutonium (Pu, atomic number 94, atomic weight 239). The production of these two elements and their separation from such companions as U^{238} marks the first time in scientific history that an element has been manufactured to order in considerable quantities. Other elements have been reported (Quill[17]) but these are always in very small amounts and none have assumed the importance which attaches to neptunium and plutonium.

For the production of the atomic bomb, uranium metal was needed. This metal was first produced by Peligot in 1841, and later by various other workers. The most successful method of preparing the metal was by an electrolytic process which had been developed by Driggs and Lilliendahl[22] at the Westinghouse research laboratory. When the sudden call came for three tons of pure uranium metal Drs. H. C. Rentschler and J. W. Marden of the same laboratory began the preparation of this metal on a scale never before attempted. The output which had formerly been measured in grams, rose quickly to 6,500 lbs. per day. At the same time the cost, which had been as high as $1,000 per pound was reduced to $22. The metal, prepared in response to this sudden demand, was used in the production of the first atomic pile.

Another accomplishment which promises to be of great value especially in medical chemistry is the preparation and separa-

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[22] F. H. Driggs and W. C. Lilliendahl, *Ind. & Eng. Chem.* **22**, 516 (1930).

tion[23] of the heavy isotope of carbon C^{13}. Ordinary carbon contains only 0.7 per cent of this isotope, but its concentration will permit the biochemist to use it as a tracer element in the study of metabolism both in health and in disease. Hopes are entertained that if the exact details of the transformations within the body can be followed by the aid of these heavy carbon atoms, many questions may be answered concerning nutrition. Of particular importance would be information concerning abnormal changes such as those that characterize such diseases as cancer, diabetes and arterial sclerosis. The isolation of C^{14} has recently been announced and it is possible[24] that this isotope may also aid in the struggle against ignorance and disease.

During World War I there were few shortages that gave the American public more serious concern than was experienced with regard to potash fertilizers. Previous to 1914 essentially all commercial supplies of this material were obtained from abroad. It was feared that the cutting off of the European supply would quickly decrease the productivity of American farms and so the supply of food would fall to a dangerously low level. Frantic efforts were made to supply potash from the dry lakes of the southwest, from the Pacific Ocean giant kelp, from the dust of cement plants, from potash feldspars and from many other sources. The location of extensive deposits of potash in Western Texas and New Mexico has led to the development of a new and prosperous potash industry. Development was stimulated by the removal of European competition during World War II. Now the United States no longer depends upon foreign supplies of potash. We not only are able to meet our own needs, but are also able to divide with our less fortunate neighbors. During the fertilizer year 1943–44 there was a total allocation of 745,000 tons of K_2O. Of this total, U. S. agriculture consumed 580,000 tons, the industries 100,000, while 39,000 were shipped to Canada and 26,000 were distributed under lend-lease. The price of potash indicates the stability which the industry has reached. Before World War I the cost of potash in this country varied from $35 to $45 per ton of K_2O. The intense rivalry for potash during the war boosted the price to as much as $425 per ton. During World War II the price has remained quite stable at $29 per ton. The mines in Alsace and

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[23] C. Huggett, R. T. Arnold and T. I. Taylor, *Jour. Am. Chem. Soc.* **64**, 3043 (1942); J. E. Taylor, *Rev. Sci. Instruments*. 15 (1944).

[24] S. Ruben and M. D. Kamen, *Phys. Rev.* **57**, 549 (1940); **59**, 349 (1941).

Baden are now resuming operations, but they have had difficulty in reaching 50% of capacity because of neglect during the war and a shortage of skillful personnel.

A saving of both potash and phosphorus in agricultural fertilizers is likely from the new and rapid methods of determinations which have recently been revised by Dr. Roger H. Bray of the Agronomy Department of the Universityof Illinois. The amounts of these essential elements which are available for plant growth are directly connected with crop yields. The new tests indicate the amounts of both K_2O and P_2O_5 which should be added in the fertilizer. They also make possible an accurate estimate of crop yields. It is claimed that 150 determinations may be made in one day.

The production of turpentine and rosin should be greatly increased by the new process of spraying 40–60% sulfuric acid on the chipped face of the turpentine pine tree. This treatment extends the period during which the tree exudes gum and reduces to less than one-third the work of chipping new faces upon the trees. This new acid treatment is being applied to some 50,000 trees during the current season.

One of the new chemical materials which has become popular during the war period is sodium chlorite. This material is manufactured by the Mathieson Alkali Works, who have recently found it necessary to double the capacity of the chlorite plant at Niagara Falls. When acidified it liberates chlorine dioxide which is said to be $2\frac{1}{2}$ times as powerful as chlorine in the oxidizing and bleaching processes. The textile industry is using increasing amounts because of its advantages over sodium hypochlorite; (1) in many places it produces a better and more permanent white; (2) it causes smaller loss of strength in the fibers; (3) it does not harm cellulose acetate rayon and (4) its use requires less careful control conditions, thus simplifying the processing steps. Chlorine dioxide generators are now available. These contain sodium chlorite in the form of flakes and when a mixture of chlorine and a large excess of air is passed through the generator a steady flow of chlorine dioxide is obtained. This gas is used to bleach fabrics, flour, starch, soap, paper and other materials. Large quantities of ClO_2 are now used in removing the taste and odor from public water supplies. A significant result of this rapid development is the decline in the production of "bleach" or bleaching powder. This compound, $CaCl \cdot OCl$ usually yields about 35% available chlorine, while calcium

hypochlorite ("high test hypochlorite") contains up to 100% of available chlorine. The latter is more soluble, more stable, and more easily handled than is bleaching powder. As a result the manufacture of bleaching powder declined from 5,595,000 lbs. in January 1944 to 1,950,000 lbs. in January 1945. Liquid chlorine is responsible for part of this change, but the advent of calcium hypochlorite ($Ca(ClO)_2$), sodium chlorite ($NaClO_2$) and chlorine dioxide (ClO_2) seem destined to displace bleaching powder almost completely in the bleaching industry.

Chlorine, always a prime essential in modern warfare, was made in large quantities, but no important changes in the American manufacture have yet been announced. The visit of American scientific groups to Germany since the end of the European war, has revealed the fact that Germany has made material progress[25] in the production of chlorine. Greatest interest centers around the cells which used mercury cathodes. Some of these with a current efficiency of 94–95% are believed to have the largest chlorine capacity in the world. Much of the German chlorine was used along with acetylene[26] in the production of such greatly needed substances as butadiene, glycerol, alyl alcohol, vinyl derivatives and many of the higher organic acids.

Another war-time development of importance has been the production of hydrogen peroxide of 80–90% concentration. Formerly it was believed that concentrations greater than 35% were unstable and unsafe to handle. It has been shown that hydrogen peroxide may be purified by vacuum distillation and the purified material is stable and may be handled without hazard. The Buffalo Electro-Chemical Co.[27] is manufacturing hydrogen peroxide 90% by weight in commercial quantities. One volume of the liquid will supply over 400 volumes of oxygen gas. It is particularly useful in cases requiring an active oxidizing agent which leaves no residue. Following the end of the war in Europe it has been learned that large quantities of high concentration hydrogen peroxide have been manufactured in Germany. Two plants with a combined capacity of 1,700 metric tons per month were in full operation and a third plant with a rated capacity of 2,100 tons was under construction at the end of the war. Much of this concentrated hydrogen peroxide was used in the propulsion of rockets. A fuel such as methyl or ethyl

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[25] *Chem. & Met. Eng.* Oct. 1945, p. 104.
[26] *Chem. & Met. Eng.* Oct. 1945, p. 116.
[27] *Chem. & Eng. News.* Nov. 25, 1945, p. 2128.

alcohol was allowed to react with concentrated hydrogen peroxide at a pressure of 30–40 atmospheres. The enormous power developed in this way propelled the rockets at a speed which exceeded that of sound. It is certain that concentrated hydrogen peroxide will find many useful peace-time applications.

Iron pentacarbonyl has attracted considerable attention recently. Its main usefulness so far seems to be as an anti-knock for ethyl alcohol fuels. It may also become useful for hydrocarbon fuels if a suitable stabilizer is developed. Unless care is exercised in its use it will foul the motor but promoters insist that it is neither more difficult nor dangerous than tetraethyllead.

The rapidly increasing use of hydrofluoric acid and the fluorides has made it desirable to have utensils which will resist the attack of such reagents to a much greater degree than will glass and porcelain. To meet this need Dr. A. G. Pincus, of the American Optical Co., has developed a glass whose main constituent is phosphorus pentoxide. Since it contains no silicates it is not attacked by hydrogen fluoride.

Hydrogen, ordinarily regarded as one of the commonplaces of industrial chemistry, became one of the most serious bottle necks of German industry. The Haber process, essential for the fixing of nitrogen both for the production of fertilizers and explosives, was in active competition with the synthetic fuel plants, especially those which manufactured motor fuels. Much attention was given to the various sources of supply and the limited amount available was carefully apportioned among the industries. The water gas method of manufacture apparently was used to produce a large part of the gas, and some was prepared by the electrolysis of water.

One of the most interesting developments of the war years is the production of the series of compounds called the silicones. These are intermediate between inorganic and organic compounds since they contain -O-Si-O- groups to which are attached radicals like CH_3 or C_6H_5. These molecules may be linked together like the hydrocarbons, building up chain compounds of great complexity. These organosilicon polymers are somewhat similar to the organic compounds of great molecular size like those of synthetic rubber. But the silicones are remarkably resistant to the effects of heat and chemical reagents. The compounds with relatively small molecules are liquids and are useful as automobile brake fluids. The compounds with

somewhat larger molecules are greases which are useful as lubricants and resins for high temperature insulation. The viscosity of the greases does not change between $-40°$ and $400°F$. The resins are not affected by water, either cold or at the boiling temperature. As the complexity of the molecules increases semisolids and solids are formed. "Bouncing putty" is a semisolid which may be molded by pressure of the hands, but when thrown upon the floor it rebounds with all the resilience of rubber. The silicones are finding many applications such as lubricants, electrical insulators and moisture proofing and impregnating materials. The Dow-Corning Co. of Midland, Michigan and the General Electric Co. of Schenectady, New York, are manufacturers of these interesting products.

(*To be continued*)

FULL POSSIBILITIES OF MAGNESIUM ALLOYS IN AIRCRAFT CONSTRUCTION NOT YET REALIZED

The full possibilities of magnesium in aircraft construction have not yet been realized, declared J. C. DeHaven, of the Battelle Memorial Institute at the National Aeronautic meeting of the Society of Automotive Engineers. Several laboratories, he said, have produced small quantities of experimental magnesium alloys with properties which, on a strength-weight basis, are superior to the highest strength commercial aluminum alloys.

There is still much to learn about these experimental alloys, he continued, and their commercial production may be a long way off; but there are propitious signs that many, if not all, of the increasingly stringent requirements of aircraft designers for a primary construction material may be met by magnesium.

The development of magnesium alloys as aircraft materials was reviewed by Mr. DeHaven. He put to rest the false story that the American aircraft industry learned about magnesium from the Germans. "Through patent literature, as well as personal visits, the British and Americans were quite familiar with German practice up to the start of the war," he stated.

Examination of enemy planes during the war, he continued, indicated that our magnesium technology was equal, if not superior, to that of the Germans, with the possible exception of large press forgings, which they were equipped to make and we were not.

Magnesium-base alloys have entered the fold of aircraft structural materials only very recently, he said. There were a number of reasons for this late arrival. Magnesium was produced during the first World War largely for nonstructural uses, in ribbons and powder for flares and incendiaries. People were afraid of magnesium, he declared, and even metallurgists were not sure that it was safe to have a bar of it indoors, in the event that it should burst into flame.

MATHEMATICIANS MUST AGREE

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Mr. Salkind (1) has called attention to the annoying lack of a convention concerning the order in which multiplications and divisions are to be performed in arithmetic and algebraic examples. As things stand now, he points out, the answer to the simple example $24 \div 3 \times 2$ can be either 16 or 4, depending on the choice of the algebra text whose authority is invoked. Mr. Salkind adds the reflection that the matter may not be sufficiently important to deserve corrective action, and so far as the common uses of algebra are concerned, he is probably right. In applied algebra the operational sign for division, $\div$, is usually circumvented by the employment of fractions; for according to the familiar statement, a fraction can be regarded as an indicated division. As a matter of fact, a fraction is more than an indicated operation; it also serves as a symbol of aggregation, and because of its dual purpose no doubt arises as to the order of multiplication and division whenever fractions are used instead of the division symbol. The above example, stated in fractions, could be symbolized in two variants, each of which would yield an indisputable answer, depending on whether the factor 2 is written in the numerator or denominator.

Not so long ago a well-known college mathematician and author of textbooks, likewise nettled by the absence of a suitable convention, suggested to the writer that the division sign should always be avoided in favor of fractions since with fractions there can be no ambiguity. To the writer this suggestion seemed a counsel of despair and the abolition of the division sign a distinct loss from the standpoint of clarity. The fraction symbol carries its own parentheses with it, thus serving two masters, whereas the traditional division sign is an operational symbol pure and simple. There is need for such a symbol in clarifying the relations between the fundamental operations. To by-pass it because we have been too lazy to agree on a convention and fear the foul vegetables from the hands of our students, rioting over the defects of a subject that has been advertised to them as the acme of logical precision—that would be a cowardly way out, indeed. We ought to agree on a convention, and the agreement should be dictated by the underlying logic of the mathematical situation. In fact, if we wish to be exact, we

ought not to use the word "convention" at all in this case. For while a convention may concern the interpretation of a certain symbol, the order in which operations are performed should not be the result of arbitrary conventions, but of rigorously deduced conclusions. In the words of a common college text, "the algebraic manipulations . . . are logical consequences of our postulates and definitions." (2)

We must turn to the basic assumptions and structural theorems of elementary algebra for an answer to the question: In what order should multiplications and divisions be performed in the absence of parentheses? Among the assumptions and theorems of algebra the generalized laws of commutation, association, and distribution must hold the clue to the settlement of the issue. These laws are the ones that enforce the common manipulations of elementary algebra. (3) For instance, the generalized laws of distribution together with the principle of consistency, which is a requisite of any sound symbolic system, determine the precedence of the operations: Involution and evolution before multiplication and division, and these before addition and subtraction. The demonstration is simple. Involution is distributive with respect to multiplication, and multiplication is distributive with respect to addition according to the formulas:

$$(ab)^n = a^n b^n \qquad \text{and } a\cdot(b+c) = ab+ac.$$

Hence, involution must precede multiplication; for if it did not, ab^n would have the same meaning as $(ab)^n$, and the results of ab^n and $b^n \cdot a$ would be different. The consistency of operational symbolism would be dissolved and the commutative axiom of multiplication contradicted. For the same reason, there must be a difference of meaning between $a+bc$ and $(a+b)c$; otherwise $a+bc$ and $bc+a$ would yield different answers; distribution would be applied in one case and not in the other, the commutative axiom of addition would be violated, and our subject, which prides itself on its lucidity, would be plunged into a miasmal mist.

However, on the question which is at issue here, the distributive laws have no bearing because they deal with relations between operations occupying different levels of complexity. (4) Multiplication and division are on the same level of complexity, one being the inverse of the other. Such relations are the special domain of the generalized laws of commutation and association.

Let us observe how these laws exercise their control over addition and subtraction. The associative axiom of addition is commonly stated in the formulas:

$$a+(b+c)=(a+b)+c=a+b+c \qquad (1) \text{ and } (2)$$

It is an axiom and as such pertains only to addition. However, this associative property of addition must have its effect on subtraction because the latter is the inverse of the former; and it would seem, therefore, wholly appropriate for practical purposes to assert a generalized associative property for both addition and subtraction. In existing textbooks such a generalization of the associative property, to cover both operations, is not made, and the writer contends that this is a pity from the point of view of effective teaching. Are not the following identities equally true as (*1*) and (*2*)? Are they not related to the associative axiom and, with the aid of other assumptions, deducible from it? Are not the important rules expressed in identities (*7*) and (*8*) the direct consequences of the axiom?

$$a+(b-c)=a+b-c \qquad (3)$$

$$(a+b)-c=a+b-c \qquad (4)$$

$$(a-b)+c=a-b+c \qquad (5)$$

$$(a-b)-c=a-b-c \qquad (6)$$

$$a-(b+c)=a-b-c \qquad (7)$$

$$a-(b-c)=a-b+c. \qquad (8)$$

It would seem, therefore, justifiable to speak of a *generalized associative property* which is common to both addition and subtraction, and which establishes the rules for the grouping of terms in parentheses when only these two operations are involved.

A similar situation prevails with respect to the laws of commutation. Theoretical algebra recognizes only the commutative axiom of addition, but any teen-age mathematician knows that he can commute, with certain precautions, subtrahends as well as addends. Likewise, the trite declaration that addition is commutative whereas subtraction is not, usually illustrated by the formula $a+b=b+a$ (while $a-b$ is not equal to $b-a$) is only a half-truth. Much more illuminating is the statement that in the addition $a+b=c$, there are two terms, namely, a and b, which can be interchanged without annulling the identity, and there

are two other pairs of terms which cannot be so interchanged, namely, a and c, and b and c. Analogously, in the subtraction $a-b=c$, the terms b and c can be interchanged without voiding the identity, but the other two pairs of terms cannot be so interchanged. Hence it is only fair to say that commutation is a characteristic of both operations, the commutative feature of one being the result of the commutative feature of the other. Furthermore, there is a generalized commutative property possessed by both operations which every novice in algebra is taught to acknowledge, and which can be demonstrated as follows. Write the expression $a_1 \pm a_2 \pm a_3 \cdots \pm a_n$ as $0 + a_1 \pm a_2 \pm a_3 \cdots \pm a_n$. This is legitimate because our discussion is not limited to natural numbers. Then there will be exactly as many operations as there are terms in the original form of the expression, at least one of n operations being an addition. The *generalized commutative property* of addition and subtraction thus leads to the rule: The result of any number of additions and subtractions is independent of the order in which the individual operations are performed.

All that has been remarked about the commutative and associative properties of addition and subtraction finds its complete analogy on the level of multiplication and division. There is a *generalized associative property* which validates the following identities:

$$a \cdot (b \cdot c) = a \cdot b \cdot c \qquad (1a)$$

$$(a \cdot b) \cdot c = a \cdot b \cdot c \qquad (2a)$$

$$a \cdot (b \div c) = a \cdot b \div c \qquad (3a)$$

$$(a \cdot b) \div c = a \cdot b \div c \qquad (4a)$$

$$(a \div b) \cdot c = a \div b \cdot c \qquad (5a)$$

$$(a \div b) \div c = a \div b \div c \qquad (6a)$$

$$a \div (b \cdot c) = a \div b \div c \qquad (7a)$$

$$a \div (b \div c) = a \div b \cdot c. \qquad (8a)$$

There is also a *generalized commutative property* which leads to the rule: The result of any number of multiplications and divisions is independent of the order in which the individual operations are performed. We write the expression $a_1 \overset{\times}{\div} a_2 \overset{\times}{\div} a_3 \cdots \overset{\times}{\div} a_n$ as $1 \overset{\times}{\div} a_1 \overset{\times}{\div} a_2 \overset{\times}{\div} a_3 \cdots \overset{\times}{\div} a_n$. (1 corresponds here to 0 in the case of addition and subtraction.) The number of operations is n, and there is at least one multiplication in it. This

presentation is in agreement with the practice of operating with fractions. If we choose, by way of illustration, the example $a\times b\div c$, and write it as $1\times a\times b\div c$, we should symbolize it with fractions as ab/c and have the identities:

$$\frac{ab}{c}=\frac{a}{c}\cdot b=a\cdot\frac{b}{c}=\frac{1}{c}\cdot a\cdot b \text{ etc.}$$

We have assumed the rule tacitly that the order in which multiplications and divisions are performed is irrelevant as to the result.

We have taken a long stride to find an answer to the question posed at the outset. We have done so to prove that the example $24\div 3\times 2$ can have only one result which is consistent with the generally recognized commutative and associative properties of multiplication and division; that result is 16. The example conforms to the identity (*5a*) read from right to left. We derived this identity from the associative property. The same answer is also enforced by the commutative property, as discussed above, which definitely rejects any kind of precedence of multiplication over division.

Still it will be difficult to convince people that the answer to an example like $4a\div 2a$ is not 2, but $2a^2$, which it would be if commutation is applied to $4\times a\div 2\times a$. The example suggests that the dilemma with which we are concerned here had its origin in the three variant forms by which multiplication can be symbolized, namely, $a\times b$, $a\cdot b$, and ab. The last form is evidently read as the product of a times b; in other words, it is assumed to be enclosed in parentheses. The only other case in which an operational symbol is omitted, the mixed number of arithmetic, is also interpreted as if it were in parentheses: $1\frac{1}{2}$ is synonymous with $(1+\frac{1}{2})$. Let it be agreed that the omission of the multiplication symbol in algebra implies parentheses, that the form ab is a companion to a/b, which also suggests parentheses. But whenever multiplication is symbolized by the customary signs $\times$ or $\cdot$, let us not assume a precedence of multiplication over division because there is no evidence that such a rule could be fitted into the logical system of algebra; on the contrary, there is ample proof that such a precedence would be inconsistent with the accepted commutative, associative, and distributive properties of the operations.

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4. *Ibid.*

DR. BETH APPOINTMENT, WESTERN RESERVE UNIVERSITY

Dr. Richard A. Beth of Princeton University has been appointed professor of physics and head of the department of physics at Western Reserve University, Cleveland, Ohio, President Winfred G. Leutner of Reserve announced.

Dr. Beth since 1940 has been head of a department of the Princeton University Station of Division 2 of the National Defense Research Committee, directing research for the federal government on terminal ballistics. He went to France and Germany on a War Department scientific intelligence mission in 1945.

From 1932 to 1940 he was assistant professor of physics, Worcester Polytechnic Institute, Worcester, Mass. During a leave of absence from Worcester he was a research associate at Princeton under a grant-in-aid from the National Research Council. At that time he measured the angular momentum of light, showing that a beam of light can cause rotating motion perpendicular to its axis. The light that he used was elliptically polarized and, shining on the surface of a thin quartz disc suspended in a vacuum, it caused the disc to turn. This was the first experimental proof of one of the mechanical effects predicted by the electromagnetic theory of light.

Born in New York City in 1908, he attended Lynbrook High School in Lynbrook, Long Island, received the bachelor of science degree in electrical engineering from Worcester Polytechnic Institute in 1929 and the degree of Doctor of Natural Philosophy from Worcester Polytechnic Institute in 1929 and the degree of Doctor of Natural Philosophy from the University of Frankfurt, Germany in 1932. From 1939 to 1940 he served as professor of applied mathematics at Michigan State College.

Dr. Beth is a fellow in the Physical Society of America and the American Association for the Advancement of Science; a member of the Societies of Sigma Xi and Tau Beta Pi, and a member of the Theta Chi Fraternity.

He is married and has a son 2 years old.

Dr. Beth's appointment will take effect at the beginning of the second summer session, July 29. At the present time Dr. Frank Hovorka, director of the Western Reserve University Chemistry laboratories, is acting head of the physics department. Dr. Harry W. Mountcastle retired as head of the department last June.

President Leutner said the faculty of the physics department will be increased and the courses of study strengthened.

A fountain pen, with what is called a magic sphere point that rolls the ink on dry, can be used for some 40 hours of straight writing without refilling, it is claimed. It is reloaded with a cartridge, about 15 seconds being required. Cartridges with four different colored inks will be available.

HYDROLYSIS MODERNIZED

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The scene of the twenty-mule team hauling a wagonload of *colemanite* from arid Death Valley is more romantic than the sight of a boxcar of *kernite* being shunted onto the siding of a borax factory. Like some ideas that persist in chemistry textbooks, the more picturesque version has little to do with actuality.

In the electrolysis of dilute sulfuric acid solution, many textbooks describe the discharge of the sulfate ion (SO_4^{--}) and its subsequent action on water to liberate oxygen. Contrary to the traditional explanation, experimental evidence points to the discharge of the hydroxyl ion (OH^-) and the liberation of oxygen by the decomposition of discharged ions.

$$4OH^- \rightarrow 4OH \rightarrow 2H_2O + O_2\uparrow .$$

Confusion also is evident in the use of the terms *ionization* and *dissociation*. *Ionization* refers to the formation of ions. With common salt, for example, ionization takes place in its formation during the transfer of the electron from the sodium atom to the chlorine atom. Solid table salt is already ionized when we purchase it from a store. When it is dissolved in water the crystal lattice is broken up by the water molecules which cluster about each ion. The separation of the ions whether accomplished by dissolving or by fusion, is called *dissociation*, the antonym of association.

The hand of tradition also rests heavily on the topic of hydrolysis. Textbooks quite commonly represent the interaction of aluminum chloride with water by vertical and horizontal equations.

$$\begin{array}{rcl} AlCl_3 & \rightleftarrows & Al^{+++} + 3Cl^- \\ 3H_2O & \leftrightarrows & \begin{array}{cc} 3OH^- & + \; 3H^+ \\ \updownarrow & \updownarrow \\ Al(OH)_3 & 3HCl \end{array} \end{array}$$

Hydrochloric acid is a strong acid and in dilute solution is completely dissociated into ions. Aluminum hydroxide is shown as a

weakly dissociated base, in addition to being insoluble, hence removing OH^- ions from the solution. As a result of dissociation, the water originally contained an equal number of OH^- and H^+ ions. By reduction of the concentration of OH^- ions through combination with Al^{+++}, there is a corresponding increase in the concentration of H^+ ions.

Actually the pH of a 0.1 *M* $AlCl_3$ solution is 2.93.[1] The solubility of $Al(OH)_3$ is, however, so low (0.00001 g/ml) that it should precipitate if an appreciable quantity is formed. No such precipitate appears, nor does a precipitate form in the acidic solutions produced by dissolving such salts as copper sulfate, silver nitrate, zinc chloride, or ferric chloride. In view of the lack of a visible precipitate, the explanation must confuse the beginning students.

The explanation of hydrolysis has benefited by application of modern theories of electrolytes,[2] but it is somewhat too intricate for secondary school students. The explanation can be simplified, however, and still not conflict with experimental facts. The hydrolysis of a salt can be defined as the ***reaction of its ions with water***. If the concentrations of the OH^- ions and H^+ ions become unequal due to this interaction, leaving one in excess, the solution will be either acidic or alkaline by a predictable amount. It is not necessary to assume that neutral molecules are formed, nor is the assumption usually warranted. To explain the acidity of a dilute solution of copper sulfate, it can be pointed out that the Cu^{++} ion has a greater tendency to combine with OH^- than has the $SO_4^=$ ion to combine with H^+. The net result is:

$$Cu^{++} + H_2O \rightarrow CuOH^+ + H^+.$$

It is possible that the reaction continues in a second step to form $Cu(OH)_2$, $CuOH^+ + OH^- \rightarrow Cu(OH)_2$, but this evidently does not occur to any great extent since $Cu(OH)_2$ does not precipitate and it is extremely insoluble.

It should be pointed out that the assumption of the formation of $CuOH^+$ is not far fetched. This type of ion actually forms in the reaction of ferric salts with thiocyanates. Contrary to the traditional textbook explanation of the resultant deep red color as being due to molecular $Fe(SCN)_3$, the only assumption which agrees with the observed change in the intensity of the color

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[1] Middleton and Willard, *Semi-micro Qualitative Analysis*, Prentice-Hall, New York, 1939, page 128.

[2] L. S. Foster, "Why Not Modernize the Textbooks Also? II. Hydrolysis and Its Relation to Ionic Charge and Radius," *J. Chem. Educ.*, 17: 509 (1940).

with changes in the concentrations of the two components is that the mole ratio between the ions is 1:1; that is, the red color is due to the formation of $Fe(SCN)^{++}$, thus:

$$\underset{\text{colorless}}{Fe^{+++}} + \underset{\text{colorless}}{SCN^-} \rightleftarrows \underset{\text{red}}{Fe(SCN)^{++}}.$$[3]

To explain then the acidity of zinc chloride solution, as well as that of many other salts, the most simple explanation and the one which corresponds most closely to experimental facts is to write:

$$Zn^{++} + H_2O \rightleftarrows Zn(OH)^+ + H^+.$$

The examples of hydrolysis given thus far have involved the interaction of the cation with water. Anions can also enter into similar reactions and cause a shift in the pH of the solution. In some instances the anion is itself an acid as, for example, in sodium hydrogen sulfate.

$$HSO_4^- \rightleftarrows SO_4^{--} + H^+.$$

The solution of this salt in water contains a high concentration of hydrogen ions. The hydrolysis of $NaHSO_4$ can be considered as a reaction of the HSO_4^- ion with water in this sense:

$$HSO_4^- + H_2O \rightleftarrows SO_4^{--} + H_3O^+.$$

The hydrolysis of sodium carbonate is conventionally written with horizontal and vertical reactions occurring as follows:

$$\begin{array}{rcccc} Na_2CO_3 & \rightleftarrows & 2Na^+ & + & CO_3^= \\ 2H_2O & \leftrightarrows & 2OH^- & + & 2H^+ \\ & & \updownarrows & & \updownarrows \\ & & 2NaOH & & H_2CO_3 \end{array}$$

Sodium hydroxide, a strong base, is completely dissociated in solution as well as in the solid state, while carbonic acid is weakly dissociated.

Such an explanation can likewise be simplified, condensed, and modernized in accordance with the definition of hydrolysis already given, based on the reaction of the ions of the salt with the water. The sodium ion reacts not at all, but the carbonate ion is involved in the following reaction:

$$CO_3^{--} + H_2O \rightleftarrows HCO_3^- + OH^-.$$

[3] Sneed & Maynard, *General College Chemistry*, Van Nostrand, 1944, page 808.

The OH^- concentration is increased and, as a consequence, the solution is alkaline. As a matter of fact, the pH of 0.1 *M* Na_2CO_3 solution is 11.6. In a similar manner, soluble phosphates undergo hydrolysis in solution.

Salt	Reaction	Result
NaH_2PO_4	$H_2PO_4^- \rightleftarrows H^+ + HPO_4^{--}$	strongly acidic
Na_2HPO_4	$H_2O + HPO_4^{--} \leftrightarrows OH^- + H_2PO_4^-$	weakly alkaline
Na_3PO_4	$H_2O + PO_4^{---} \rightleftarrows OH^- + HPO_4^{--}$	strongly alkaline

Sodium cyanide solution is strongly alkaline.

$$CN^- + H_2O \rightleftarrows HCN + OH^-.$$

Why is sodium chloride solution neutral? Neither the Na^+ ion nor the Cl^- ion has any tendency to remove a proton or a hydroxyl ion from a water molecule and the water equilibrium is not disturbed.

TABLE I. pH OF SALT SOLUTIONS

Formula of Salt	Concentration moles/liter	pH
$AlCl_3$	0.1	2.93
NaH_2PO_4	1.0	4.0
NH_4Cl	2.0	4.0
NH_4Cl	0.1	5.0
$Zn(C_2H_3O_2)_2$	1.0	6.0
$MgSO_4$	0.1	6.0
$NH_4C_2H_3O_2$	1.0	7.0
$NaCl$	1.0	7.0
$NaHCO_3$	0.1	8.4
Na_2HPO_4	0.1	9.0
$Na_2B_4O_7$	0.1	9.2
$NaC_2H_3O_2$	1.0	9.6
Na_2SO_3	1.0	9.7
KCN	1.0	11.6
Na_2CO_3	0.1	11.6
Na_3PO_4	0.1	13.0
$NaOH$	1.0	13.9

Why is ammonium acetate solution neutral, while sodium acetate solution is fairly strongly alkaline?

$$C_2H_3O_2^- + H_2O \rightleftarrows HC_2H_3O_2 + OH^-.$$

The NH_4^+ ion, however, is an acid in its own right and the extent to which it produces H^+ ions by dissociation

$$NH_4^+ \rightleftarrows NH_3 + H^+$$

is just matched by the production of OH^- ions. The water equilibrium is not upset even though hydrolysis is extensive. Whether a solution of a salt is acidic, alkaline, or neutral thus depends on whether by interaction of the ions the water dissociation balance is upset. Table I lists the pH values for solutions of many common salts.

These several examples are presented in the hope that more teachers will see the simplicity of the modern explanation of hydrolysis and will have the courage to abandon the non-scientific traditional explanation of this and other types of reactions that still cling to many of the textbooks in spite of the experimental evidence to the contrary.

Exercise

Show by an ionic equation the simplest reaction that explains the hydrolysis of (a) copper sulfate, (b) zinc chloride, (c) silver nitrate, (d) ferric chloride, (e) potassium tartrate. Answers are found on page 000.

Answers to Exercise on Page 000

$$Cu^{++} + H_2O \rightarrow CuOH^+ + H^+$$

$$Zn^{++} + H_2O \rightarrow ZnOH^+ + H^+$$

$$Ag^+ + H_2O \rightarrow AgOH + H^+$$

$$Fe^{+++} + H_2O \rightarrow FeOH^{++} + H^+$$

$$C_4H_4O_6^{--} + H_2O \rightarrow HC_4H_4O_6^- + OH^-$$

U. S. COMMISSIONER OF EDUCATION AWARDED TREASURY'S DISTINGUISHED SERVICE MEDAL

As the representative of a million teachers in 225,000 American schools with 30,000,000 pupils, U. S. Commissioner of Education John W. Studebaker was awarded last Wednesday the Treasury Department's Silver Medal for Distinguished Service in War Finance.

In accepting the medal, Commissioner Studebaker said: "On behalf of the Nation's schools I accept with thanks this token awarded by the Treasury Department in recognition of the splendid patriotic contribution made by the teachers and pupils of our Country. I, too, pay tribute to them. The lesson of thrift learned in wartime by the children and youth of America will stand them in good stead in time of peace. It is my earnest hope that the schools will continue with unabated enthusiasm their participation in the School Savings program, sponsored by the Treasury Department with the cooperation of this Office."

OBJECTIVES IN BIOLOGICAL COURSES*

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This program was arranged by someone who understood both the problem and the English language. In this title the nouns are in the plural which clearly indicates the assumption that there are many types of courses in the biological sciences and that any one of these courses may properly have several objectives. Varied as these courses are, most of them fall readily in one or another of three groups.

Advanced Courses

In the category of advanced courses are included only those which may contain some students who hope to have a part in what President Lowell[1] indicated as the greatest function of higher education, namely, the increasing of knowledge. In such courses the objectives are obviously three, or if you prefer, five.

To indicate the knowledge already available in the given field and the means of keeping abreast of that knowledge.

To indicate the great gaps in that knowledge and perhaps suggest those which seem most likely of being filled with the means at hand.

Finally to insist that the student be able to make clear to other people what he has learned; that he be able to use graphs, tables, equations, symbols, and good plain English, written and spoken.

No apology is made for including this as one of the major objectives of advanced courses in any of our fields. All our teaching, including our examination techniques should be arranged to include this end. No piece of research is complete until its results are made available. It is not really complete until it is made really intelligible. Many of the classics in the field of the life sciences are great pieces of exposition. Have you read one of Darwin's books lately, or Mendel's great paper either in the original or in translation? (By contrast you might read any of Strasburger's later papers.) Of course, not many of us can reach these levels, but that is no excuse for not trying or for not insisting that our students try.

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* Delivered before Section Q of the American Association for the Advancement of Science, Cleveland, Sept. 14, 1944.

[1] Lowell, A. Lawrence. "Some Functions of Higher Education," *The Yale Review*, Autumn, 1941.

Most workers in the life sciences apparently agree that good exposition is an important part of mastery of our fields. Herman Von Schrenk was, as you know, one of the earliest plant pathologists to enter the consulting field. A couple of years ago, he closed a talk of absorbing interest to undergraduates of our College of Engineering with a plea to the boys to learn to write and speak the English language.

It is by no means suggested that workers in the biological sciences are alone in recognizing the importance of verbal expression. On our own campus the strongest support for adequate instruction in English rhetoric has come, I am informed, from the chemists. During recent years they have been vigorous supporters of adequate instruction in other modern languages.

There is some evidence that this attitude is true in general for college teachers of science and that we are getting results. Take for example some data that have appeared in a recent publication of the Graduate Record Examination.[2] Admittedly the purpose of this study was quite different, but it has been my experience that some of the most interesting results of studies are those not looked for when the work was undertaken. The curves here reproduced (Figs. 1 and 2) compare the test scores of honors students, all men, in three eastern colleges with the scores of non-honors men in the same colleges. The students majoring in science fields were segregated from those majoring in non-science areas. In spite of the fact that practically 80 per cent of both groups received some form of *general* honors, it is obvious that only in the group of science majors was there evidence of general superiority. Science teachers in these three eastern colleges gave honors to men who were really superior to their fellows. They were particularly superior, it appears, in their ability to use the English language. Teachers in the non-science fields were content to give honors to men who in the words of the report were "relatively illiterate so far as working knowledge of elementary science and of quantitative thinking is concerned."

Service Courses

The phrase "service courses" is used in an endeavor to dodge "propaedeutic" which sounds too much like "pedantic." The term used has the added advantage of making it clear that

[2] Wesman, A. G. "Test scores of honors students." *Graduate Record Examination. Occasional circular No. 3*, July, 1944.

consideration is not being given to courses intended primarily to start specialists in our own fields. It is extremely doubtful if any such beginning courses, in Botany at least, exist in the United States. On this point the report[3] of the Committee of the Botanical Society of America on the Teaching of Botany has some pertinent information. Significant of the attitude of American teachers of botany are their judgments as to the importance of various objectives in the general course. Out of 250 replies to a questionnaire on this subject "interest in pursuing plant sciences as a profession" received only 23 votes and stood 56th in the list of 59 objectives considered.

Here are included all the courses regularly required in established pre-professional or undergraduate professional curricula; bacteriology for pre-medical and home economics; botany and entomology for pre-forestry and agriculture; physiology for physical education and home economics; finally, and perhaps especially, zoology for the pre-medical students. Students in such courses seem to be almost literally the forgotten men of current discussions of teaching in the biological sciences. During the past five years I have read rather extensively on this subject. Almost never are these required courses mentioned, except incidentally by educationists who assume that they are undesirable for general education. The very fact that such courses receive so little discussion makes me all the more skeptical of their up-to-dateness.

Pre-medical zoology must be among the oldest and most widely taught of these fields. There must be very few liberal arts colleges in the U.S.A., that do not offer some sort of pre-medical courses including zoology under some name. Perhaps the condition which apparently exists here is indicative of those which may develop in other courses similarly required over a long period. No accurate figures seem to be available, but the impression among my colleagues is that approximately three-fourths of the undergraduates taking zoology are doing so as pre-medicals. I am assured by them that undergraduate instruction in zoology is largely dominated by the supposed needs of this group. Some of the franker of them add "That is what is the matter with the teaching of zoology." By this they apparently mean that zoology courses have been so long and so generally cast in a single mold that great difficulty is experienced in

[3] Stover, E. L. et al. An exploratory student of the teaching of Botany in the Colleges and universities of the U. S. Botanical Society of America. 1938.

changing them. This, I am told, is being discovered by a considerable number of college teachers of zoology who are now trying to make changes.

Forty years ago, because it was the only zoology available, I took a series of courses designed primarily for pre-medics. During recent years I have been amazed to find how closely

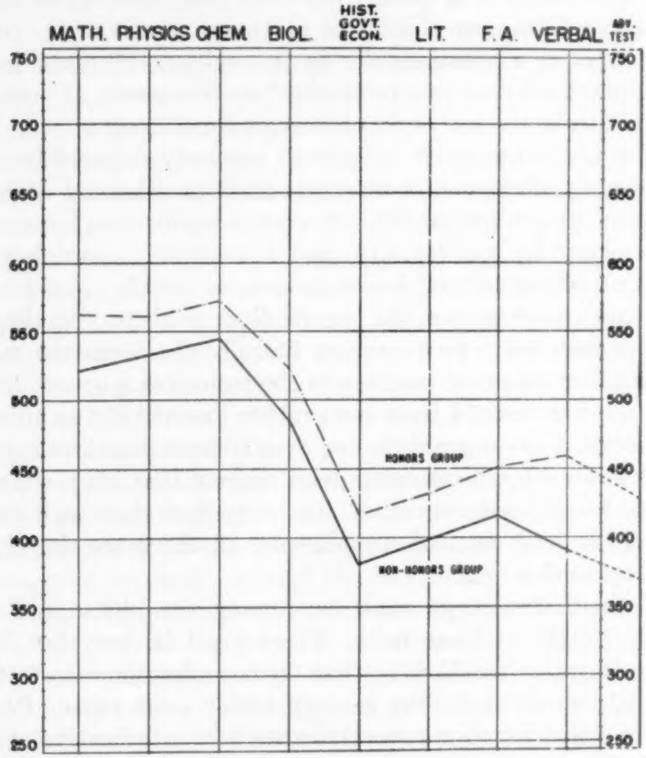


FIGURE 1

	N	
—·—·- HONORS (79% General Honors)	28	
——— NON-HONORS	98	SCIENCE MAJORS (MEN AT 3 COLLEGES)

these courses resemble the ones still given in many colleges. Had a high degree of perfection been reached ten college generations ago? It seems at least possible that zoologists in too many colleges, resting securely against this comfortable backlog of hopeful pre-medics have found it unnecessary to reexamine the content of their courses.

Whether this is literally true or not these "service courses" seem to be the ones most in need of restudy and the opinion is being forced upon me that they are the ones which most deserve the efforts of the very best teachers.

Here, in all seriousness, is our golden opportunity; a field ripe for the harvest. Here is our chance, in my opinion our best

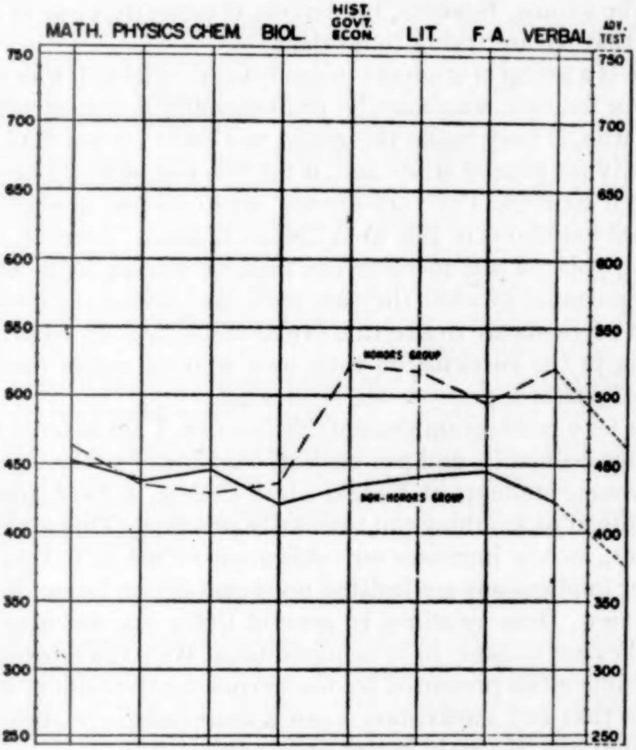


FIGURE 2

	N	
—·—· HONORS (78% General Honors)	63	NON-SCIENCE MAJORS
——— NON-HONORS	113	(MEN AT 3 COLLEGES)

chance, possibly our only real chance, to do what our educationist friends urge us to do "to contribute,[4] at an appropriate level, to the student's preparation for the needs of everyday life . . . not only to the needs which a student sees but also those

[4] Pothoff, E. F., "Fundamental Purposes of General Education", *Journal of Higher Education* 13, 73–77 (1942).

which he should be made to see—not only to life as it is actually lived, but also as it might better be lived—not to some narrow and highly specialized segment of life, but to life in its manifold aspects."

Incidentally, it must be next to impossible for any one to teach a subject in which he is interested to students in whom he is interested without trying to do all these things. Something might be gained, however, by making it perfectly clear to outsiders that we are trying to do them.

Here is a group of students to some degree selected, who must take our courses, who may be professionally active in related fields, who, if they make the grade, will have all too little opportunity for general study and, if they do not, will still become educated citizens. They are already aware of the specific professional usefulness of this work. Many of them, however, need to have pointed out to them the broader human implications and importance of what they are studying. Above all, students in such curricula are to a certain extent motivated. At least those who are in the curricula on their own volition rather then because of parental pressure are motivated.

This very motivation presents difficulties. I am assured that the home economics and pre-medical students of today, like the short course students at Kansas State College in 1912, tend to be skeptical of anything not obviously practical. This attitude, however, merely increases our obligation to see to it that the broader implications are insisted upon and driven home. If this wider view, these relations to general living are not acquired here, they are unlikely to be acquired later. With full recognition of the difficulties presented by too narrow motivation, it is my opinion that any motivation, even a materialistic or distorted or limited one, is vastly better than none.

What a difference motivation makes can be really appreciated only if you have to run the whole gamut. I honestly believe that I have, and if you will pardon a frank personal statement, it will illustrate what I mean. My best teaching during the past thirty years has been in the field, standing on the soil a man owns, among the plants upon which he depends for his living. Under such circumstances, the difference between pH and methyl orange alkalinity, or the critical difference in the levels of control needed in dealing with the insect vector of a virus and an insect which destroys a crop directly, or Blackman's theory of limiting factors become surprisingly easy of comprehension.

Last year, I had the privilege of teaching general biology in our Division of General Studies. It was a chastening experience—an experience which all of you should have who think you have ability as teachers.

During the past thirty-eight years I have tried teaching under a considerable range of conditions; a variety of subjects in a one-room high school in northern Maine; English and Greek as a substitute in the high school from which I had recently graduated; English to immigrants in a New Haven night school; three summers of nature study to a group of youngsters outdoors in the Catskill Mountains; sub-freshman, at Kansas State College; laboratory instruction at Yale (this combined with some intensive and profitable tutoring); much later laboratory instruction in evening classes at George Washington University; finally graduate and undergraduate instruction at the University of Illinois, this last including two terms of ASTP geography. When, however, I undertook teaching general biology in our Division of General Studies I realized for the first time how hard teaching can be. It was some consolation to learn last spring that five different men had tried a comparable course at Columbia with reactions also comparable. For teaching such a course, I suggest as desirable characteristics, the wisdom usually attributed to Solomon, the patience which Job certainly needed, plus the god-given ability to sell the Brooklyn Bridge to the King of Siam.

Courses for General Education

Finally, and briefly, what should be our objectives in elementary courses for students who, chiefly because they are not interested in anything in particular, are supposed to be seeking a general education? This subject is now much under discussion by those who already know the answers. Perhaps all the heat they are generating will shortly result in a little light. So far as any trend at all is discernible among these diverse councils, it seems to me to be in diametrically the wrong directon.

As I now see it, the importance of the subject matter, the importance of mastery of that subject matter, the actual memorizing, to use an unpopular word, increases as you go down, (or if you like, up) the scale we are considering. It may make very little difference whether an advanced graduate student in entomology remembers or even learns the formula for D.D.T. He can easily look it up. Nor need every plant pathologist

know the number of biological races of the cereal parasites—there will be more tomorrow. Nor can it be of great importance to pre-meds and pre-forestry students to remember the details of the anatomy of the salamander or the beech seedling. Reference books will be at hand. But unless the general student *really learns* that the process of photosynthesis is the present source of all our food and all our oxygen he has, in all probability, missed just that much, for he is unlikely to learn it later.

Perhaps we will not be able to go all the way back to Agassiz' methods but we might start in that direction. Suppose it did take Beal three days to learn that a perch has a bilateral symmetry. He surely never forgot it and no doubt looked for bilateral symmetry in other animals. By contrast I have recently had students fresh from a year in high school chemistry, supplemented by a year of some other science, who had no idea that

$$6CO_2+6H_2O \rightarrow C_6H_{12}O_6$$

is *not* an equation. Some of them did know that $3+4=6$ is not an equation.

With the rapid expansion of knowledge in all our fields, it is obvious that the selection of material for beginning courses must be increasingly drastic. Perhaps something might be learned at this point from our colleagues who have been teaching ASTP language courses. They have come to agree with St. Paul "I had rather speak five words with my understanding, that I might be able to teach others also, than ten thousand words in a tongue." (1 Corinthians 14:19). Let the young soldier who might find himself in Germany learn, *really learn*, a few essential sentences such as:

"Ich bin hungrig," or

"Nudeln mit Rindfleisch freut mich ausserordentlich," or

"Dein Händchen ist wunderschön."

and he will get by all right. The future-perfect subjunctive can wait until later. Our beginners may well be asked to *learn* something of the significance of the angiosperm seed. The alternation of generations in the Rhodophyceae can wait.

If it be objected that this type of instruction is difficult, I will remind you of the difficulty of the other method and particularly of the temptation it offers to merely amuse the student. Etkin, Kille, and Livingston[5] refer aptly to the danger that college

[5] Etkin, W., F. R. Kille and L. G. Livingston, "A progress report of the Committee on basic concepts in Biology," *Graduate Record Examination Occasional Circular No. 2*, 1943.

teaching may "Fall to the level of the 'Oh my!' type of popularization of knowledge."

Freed from all restrictions of colleges, colleagues or conventions, and having in mind only the good of the students, I should certainly never offer a beginning student a general course in biology, or in botany, but rather a course in the green flowering plant, or in seeds, or perhaps in leaves.

From the above, it is clear that I feel that many of those who would improve our elementary courses for general education are trying to do far too much, more than we can do, more than our students can do or should be asked to try to do. I wish they too might search the scriptures: "First the blade; then the ear; after that the full corn in the ear" (Mark 4:28), or "Seek not things that are too hard for thee, and search not out things that are above thy strength." "Be not over busy in thy superfluous works, for more things are showed unto thee than men can understand. For the conceit of many hath led them astray" (Ecclesiasticus 3:21–23).

FIELD BIOLOGY COURSES FOR HIGH SCHOOL STUDENTS AS AN AID IN THE PROMOTION OF CONSERVATION EDUCATION

EDITH R. FORCE

Woodrow Wilson Junior High School, Tulsa, Oklahoma

We believe the major purpose of education is the development of good citizenship. Jay N. Darling says: "To me education has become the only pathway that can lead us out of the doldrums." I propose the purpose of conservation education is "to develop those habits, attitudes, and ideals to lead to the development of better citizens."

It is not my assignment to reiterate the splendid material in conservation education which leaders have already made available to any teacher who will even lift his eyes and look about him. Dr. F. M. Baumgartner of Oklahoma A. and M. College has prepared an excellent short list of references and sources of materials for teachers and pupils which may be obtained at very low cost or entirely free. (A)

If I bring you anything new it is the original skeleton plan of a *Summer Field Biology Course* for high school students. (B) Why not *more* such courses fitted to the needs of *more* communities?

The aims, in our community, as expressed to the students are simple. The job of making them come alive in strong conservation education calls for the best that is in the instructor. We begin, basically with a first hand acquaintance with the flora and fauna of Tulsa County and vicinity. We attempt to develop the ability of all students "to look and to see." We strive for an informal, pleasant, healthful, good-humored enrichment of everyday learning. This leads to a continued source of delight in further leisure time acquaintance with out-of-door life. An additional high school science credit is available for eligible students.

As much time is spent in the field as weather, types of class work needed, and physical fortitude permits. At first we went in private cars, but since 1942 our transportation has been on the regularly established bus lines, with the possible exception of 4 or 5 longer trips. Field observations are made of the plants and animals in their habitats, with a minimum amount of collections of such materials as is suitable, governed by the ideas of conservation of natural resources. We aim as a class to make

some definite contribution to the knowledge of the vicinity which may be published. For example the *Audubon Summer Bird Census*, or the *Time Table of Birds of Tulsa County*, or the grasses are sent to some authority, or the flowering plants are made into a school herbarium. Records of field observations are taken directly in the field notebooks. Class notebooks develop these field observations together with records of readings, talks, moving pictures, museum exhibits, maps of the country covered, locations of nests and trees, a survey of the city parks, school yard and University Campus. Each student is expected to become acquainted with the general class observations. In addition, special studies are to be made of a major interest within this general field as reptiles or birds. The course is closed with a strong conservation program, coupled with a watermelon feed. Certificates are mailed to the students and the schools concerned at the end of the summer.

In order to show you some of the varied activities which aid in the promotion of conservation education in our community I have chosen a few slides which have been taken each year by some student whom we designate the official photographer. He also makes photographic records of the plants and animals in their natural environment. These serve nicely for stimulation or review work, later.

Brief Descriptions of Some of the Slides Shown

My own room at Wilson Junior High School is the headquarters.

After registration the first day we start out to a prairie area. This is not too strenuous, but we learn to keep together, to listen to the leader, to "ask the tree" or to locate the bird.

Wildly waving insect nets may be the way they begin, but before the summer is over they will be calling attention to a spider's home on the University of Tulsa Campus.

As city dwellers, traveling in street cars is an experience, so we take the trolley to Lost City about 15 miles out.

By gradual stages we have climbed from the prairies, to the wooded hills and now to the higher eroded escarpment which bounds the city.

Stamina and fortitude may be the lesson learned here.

The story of weathering and erosion was told at the noon meal.

Rocks will become soilmakers when they really are explored.

What "not to do" makes a vivid impression when it is photographed.

One of the first day lessons, oft repeated, is the identification of poison ivy. So to give dear teacher a start some prankster is sure to try the class out with woodbine.

The fungus on a piece of burned wood as advanced stages of erosion caught the photographer's eye at first.

The next time it was the beauty of the non-flowering plants.

After characteristic experiences with cacti we delight in recalling the thrill of a prickly pear in full yellow bloom one hot morning along the dusty lane.

Dr. B. D. Barclay, a cooperative professor at the University of Tulsa, joined us for an afternoon. This time we learned to bore trees to tell their age.

In 1944 we followed the milkweed from flowers to fruit. Then we picked about 70 fifty pound onion sacks full to dry and send through the conservation department for use in Mae West life-preserver jackets. The $13 thus earned was promptly turned over to the Red Cross. Conservation then is not just sentimental appreciation of the beauties of nature. After such backbreaking labor cotton picking has become quite real.

We felt this was perfect to teach the interrelationship of all living things. It is the collared lizard about to pounce on a grasshopper.

"The biggest snapper I ever caught" is still the gloating caption of one of the hikers.

It is easy to teach that "ignorance is the cause of fear" when all can see and handle the harmless bull snake—the farmer's friend for the rodent menace. It is well to know it is not the poisonous rattler. The next one caught was a blue-racer.

The fun of clocking homing pigeons was one of the additions to bird study.

Spying on an orchard oriole family was easier than finding this meadowlark's nest after it had once been left.

At noon we eat together. The conversation rarely strikes the level of the dance the previous night. After 15 or 20 minutes of unrestricted freedom, which is like the postman's holiday—more of the same thing—there is another hour of exploration.

About two o'clock it is time to get into the shade. Then watch out! It takes ingenuity to combat complete relaxation while we summarize and drive home the lessons of the day. This is usually facetiously called "Mother Nature's Chair" or the "Queen's Throne."

Reserved for the fourth and fifth weeks are the water trips and the 7 Museums, from 20 to 60 miles away. In 1943 Mr. Bob Aldrich was in charge of the state and municipal Fish Hatchery. He generously gave us two hours in the early morning on "Conservation for Use" of the fish of Oklahoma. Then the private pools held an interest for water striders and dragon flies.

One of the most enjoyed events is the annual tour to Woolaroc, the 80,000 acres in the Osage Hills, belonging to Frank Phillips. Some 48,000 acres are under fence. Here roam wild animals from many countries. Connected with the estate is a remarkable Museum showing the progress of early civilization and culture.

In contrast to this natural beauty we visit the Will Rogers Memorial at Claremore, Oklahoma. Here the formal planting is green and blooming all year around. It is a perfect setting for the sarcophagus and Memorial building of grey stone.

Rainy days are opportunities for indoor catching up. A story of a New Mexico cloudburst makes the next time we are drenched just a big laugh. Or we might take a short trip to the nearby University Campus and key the trees.

The last days of the six weeks always seem to move along too fast. The trips are usually some of the best. Some are repeats to places we especially enjoyed, or wanted to check the difference in six weeks in nature. Parental cooperation is always very generous. One event has become a community contribution to adult education. Dr. B. D. Barclay and his wife, Dr. Harriet Barclay, of the University of Tulsa have each year since we began in 1940 presented a splendid conservation lecture with their own exceptionally beautiful kodachrome slides. Last year 125 gathered in one of the larger

yards to become acquainted during the usual watermelon feast. Then when it was dark we lost track of time while we relived with the Barclays the joys of a land where nature is enjoyed in all her vagaries.

So somewhat reluctantly we stand on Reservoir Hill and look down on our lovely City of Tulsa, because we realize after six weeks of close daily contacts, we come again to the Trail's End.

A. *SOME INEXPENSIVE REFERENCES AND SOURCES OF MATERIALS FOR TEACHERS AND PUPILS*

American Museum of Natural History, School Nature League, New York City. (Pamphlets on various groups of animals and plants with suggestions for teachers.) 50¢ a year.

California Department of Education, Division of Text Books and Publications, Sacramento. (Pamphlets on various groups of wild animals, plants, etc.) Free.

Cornell University, Ithaca, New York. Dr. E. L. Palmer. (Cornell rural school leaflets and other materials for pupils and teachers.) Free.

Iowa State College, Extension Service, Ames. (Pamphlets on various graphs on wild animals and plants.) Free.

Izaak Walton League of America, Material Headquarters, Chicago, Illinois. (Publications, films.) Free or rental charges.

Izaak Walton League of America, Oklahoma Division, Bud Jackson, KVOO, Tulsa. (Pamphlets on fire prevention, speakers.)

Izaak Walton League of America, Local Chapters. (Assistance on projects, speakers, etc.)

Kansas State Board of Agriculture, Topeka. (Pamphlets on the insects and plants of Kansas.) Free.

Louisiana Department of Conservation, New Orleans. (Books and pamphlets on wildlife, excellent wildlife films. Some mtaterials free, others carry a moderate charge.)

Michigan Department of Public Instruction, Lansing, Bulletin 3043. (Classified bibliography of wildlife references.)

Missouri Conservation Commission, Jefferson City. (An excellent series of teachers' manuals, etc.) Free.

National Association of Audubon Societies, 1006 5th Avenue, New York City. (Pamphlets, colored slides, films and bibliographies on bird appreciation and conservation.) Pamphlets free, rental charges on slides and films.

National Wildlife Federation, Washington, D. C. (Pamphlets on the teaching of conservation.) Free to modest fees.

Oklahoma A. & M. College, Extension Division, Stillwater. (Publications on control of insects and rodents, propagation of trees and shrubs, landscaping homes, plants, a few wildlife films.) Free.

Oklahoma Game and Fish Commission, Oklahoma City. (Publications on fish, fur and game, Oklahoma laws, speakers, a few films.) Free.

Texas Game, Fish and Oyster Commission, Director of Education, Austin. (Publications on various groups of wildlife.) Free.

United States Department of Agriculture, Soil Conservation Service, Washington, D. C. (Pamphlets, films, charts, etc.) Free to small charge.

United States Department of Interior, Fish and Wildlife Service, Chicago, Ill. (Pamphlets on all phases of wildlife management and study.) Free to small charge.

United States Department of Interior, National Park Service, Chicago, Illinois. (Pamphlets on wildlife of national parks.) Free to moderate charges.

United States Office of Education, Washington, D. C. (Lists of films, pamphlets and sources of materials.) Free.

Wisconsin Department of Public Instruction, Madison. Curriculum Bulletin, Volume 1, Nos. 1 and 2. (Good bibliography and suggested activities.)

B. Seventh Annual

SUMMER FIELD BIOLOGY COURSE

May 27–July 5, '46

*****

For Junior and Senior High School Students

AN OUT-OF-DOOR SUMMER SCHOOL

Headquarters: Wilson Junior High School, Room 201

Time: A tentative schedule subject to change by the class
Class hours:
8:00 A.M.–3:00 P.M. Daily except Saturday
Required class hours: 30 hours per week, or 180 hours in six weeks

Course of Study: The equivalent to one year high school science with the added advantage of observing living things in their natural environment.

Fee: $30 for six weeks, covering all expenses for class equipment, books and instruction. Transportation on City Bus Lines. Lunches, bus transportation, cameras, field glasses, knapsacks, thermos, or canteen, are personal items.

Credit: One year high school science credit as given in Tulsa Public Schools for grades 9, 10, 11 and 12.

Eligible: Open to 20 boys and girls registered for Junior or Senior High Schools in Tulsa or elsewhere next fall.

Register: Personal application is necessary. It is desirable to register at once, or before May 1, 1946, with the instructor, Miss Edith R. Force, Woodrow Wilson Junior High School, 11th and Columbia, Tulsa 4, Okla.

QUAKE THAT STARTED TIDAL WAVE CENTERED SOUTH OF UNIMAK ISLAND

The submarine earthquake that set the destructive tidal wave in motion across the Pacific on Monday, April 1, had its epicenter about 70 miles south of Unimak island, which is the first and largest of the Aleutians, just off the tip of the Alaskan peninsula. Seismologists of the U. S. Coast and Geodetic Survey, who made the determination after studying data wired and radioed to Science Service from seven observatories, gave the geographical coordinates of the spot as latitude 53.5 degrees north, longitude 164 degrees west.

The sea bottom has a very curious formation at the point where the earthquake occurred, the Coast and Geodetic Survey scientists said. It is about 100 fathoms (600 feet) deep there, but begins to slope downward very steeply, reaching a depth of 1,000 fathoms (6,000 feet) within 15 or 20 miles. Earthquakes have been frequent in this general region, but nothing of major importance has been recorded from this particular locality.

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago

119. Factoring in Beginning Algebra. Authorities differ on how much factoring should be taught and on the order in which the various types should be introduced.

Hassler and Smith in *The Teaching of Secondary Mathematics*, p. 260, state "The general case of (multiplying) two binomials should be taught first and drilled upon to the point of mastery so that the special cases, the square of a binomial and the product of the sum and difference of two numbers, can be discovered by the pupils as special cases of the general case and not be thought of as isolated cases. The better pupils will then use the special rules and save time; the duller pupils can always use the rule for the general case and be saved the almost impossible task, for them, of differentiating between the different cases." Then they state that although the first year course may require only the cases (in factoring) of a monomial factor, of a trinomial square, and of the difference of two squares, nevertheless the factoring of the general trinomial should precede the last two types.

On the other side of the argument is Butler and Wren, p. 326. "The work in factoring should be confined to expressions involving a common factor, the difference of two squares, the square of a binomial, or the quadratic trinomial of the form x^2+px+q. . . . Nothing is to be gained by including special products of the form $(ax \pm b)(cx \pm d)$, because such products can be found as quickly and with more assurance by direct multiplication, while the factoring of such products generally involves trial and should be checked by direct multiplication anyway."

Charles Godfrey was a noted writer in England on mathematical pedagogy. On p. 199 of the revision by A. W. Simmons of *The Teaching of Elementary Mathematics*, they favor beginning factoring with ax^2+bx+c, and add that "If examples such as $x^2+7x+10$ are taken first, the boy may get a rule 'find two numbers whose product is 10 and whose sum is 7.' This is pernicious because it actually obscures the general method. . . . It is wiser to start with examples in which the coefficient of x^2 is not 1."

Even though a course of study may require only such special cases as $ax+bx$, a^2-b^2, $a^2+2ab+b^2$, and x^2+ax+b, and even

if it can be proved that these are the only cases that arise in problems suitable for the ninth grade, nevertheless experience tells me that the general case should be considered first. It is an immense saver of time; it takes less time to teach the general case and follow it with the special cases than to teach only the special cases and omit the general case. And if a pupil sometimes writes $(a+b)$ $(a+b)$ instead of $(a+b)^2$, I make no comment in class about it. There are problems in which it is an advantage to have $(a+b)$ written twice instead of with the exponent.

120. Factoring in the Second Course in Algebra. In some schools an entire year is devoted to a second course in algebra. I am considering here a one-semester course at the beginning of the eleventh grade, this being the most common practice. The course as outlined in these NOTES, December 1943, provided ten days for factoring. Many teachers have criticized the inclusion of logarithms, progressions, and the binomial theorem in this outline saying that they spend three or four weeks on factoring alone. I believe this is a mistake, and favor decreasing the time on factoring to as little as eight days, assuming of course that the pupil had a fairly honest course in ninth grade algebra and not a course in general mathematics from a textbook labeled Algebra.

Those who would like to spend three or four weeks on factoring are under the misapprehension that certain types of factoring *must* be included and that without a thorough study of these types the pupil will be unprepared for the next course in mathematics (usually Trigonometry, often Solid Geometry). Actually, trigonometry involves very little factoring, and a pupil could enroll in a trigonometry class even if he knew nothing about factoring, learning what is needed as the occasion arises. The same can be said about solid geometry. Hence my advice to teachers who would spend three weeks on factoring would be "teach as much factoring as you can in eight days and then begin the next unit. If the difference of two cubes has not been considered in those eight days, forget about the cubes. If the factor theorem has not been included in those eight days, forget about the factor theorem. In any event, eight (perhaps nine, as a slight concession) is all that the topic deserves at this time."

121. Formulation and Solution of a Problem. Any topic in mathematics has, in school, two purposes; one, the topic solves or prepares for the solution of certain practical problems, and, two, it exhibits a technique which has disciplinary, cultural, or

transferable values. One of the things which pupils are supposed to get out of mathematics is the ability to formulate and solve a problem. At the mention of the word ***problem*** a teacher thinks at once of problems dealing with ages, coins, mixtures, rates and distances, and other such standard problems, forgetting that the same technique should be applicable to such bigger problems as: What subjects shall I select for next semester? What vocation shall I follow? or, How can I make up the work lost by absences? Let us see how the work on factoring in a second course in algebra can teach something more than mere factoring.

Lesson one and two can deal with $(ax+b)\ (cx+d)$, $(a+b)^2$, $(a+b)(a-b)$, the factoring of ax^2+bx+c, and the special cases arising from the latter.

Lesson three deals with quantities that can be written as the difference of two squares.

Lesson four deals with $ax+ay+bx+by$, which is really a case of $an+bn$.

Lessons five and six deal with the factor theorem.

Lesson seven deals with a^3-b^3 and a^3+b^3, which are really special cases of the factor theorem.

At this stage of the work the pupils are sure to be discouraged and begin to say that they "just can't do factoring," and I have thus created just the situation that I want. If the class has not reached this discouraging stage, I assign some quantities that are difficult enough to annoy, confuse and dishearten even the best pupils. And so I confront the pupils with the following problem: How shall we organize the work so as to get out of the mess in which we seem to be imbedded?

The class discussion, with some prompting by the teacher, indicates that the troubles are: Inability to recognize the different types, and not knowing what to do first or what to try next.

As a solution of this problem, we decide to make a list of the types, identify each with some label, and write an example of each. Then we decide to organize the procedure to be followed in the manner used in many workbooks in physics and chemistry: do this first, then do this, and then this, and so forth. The directions worked out in class read about as follows:

1. Examine the terms to see if they are all divisible by some common factor. (a) If not, proceed to step 2. (b) If so, divide and then treat the quotient as in step 2.

2. If the quantity looks like ax^3+bx^2+cx+d, try the factor theorem. If not, proceed to step 3.

3. If there are four terms, group them two and two, and see if each pair has a common factor. If not, try step 4.

4. If there are four terms, can three be grouped to form a trinomial square? If so, can a difference of two squares be formed? If not, try step 5.

5. If there are three terms, can something be added and subtracted to make a difference of two squares. If not, try step 6.

There is seldom time in class to complete the scheme. Enough has been done to suggest the procedure. The words "If not, try the next step" have great appeal. The pupils admit that they seldom tried all the steps. If the first guess was wrong, they set the problem aside as too difficult. We may not do much work on factoring afterwards, but begin the next unit. Thus factoring has been used to illustrate the procedure of problem solving: recognizing a difficulty, collecting the relevant data, organizing the material, planning a procedure, and finding a way out of the difficulty. The problem was of course artificially created by the teacher; the problem would never have arisen if three weeks had been allotted to factoring or if only simple cases were studied. Besides illustrating the technique of solving problems, this work is of some value in teaching pupils what to do when confronted with failure. Pupils who are given such easy tasks (under the guise that failure will develop an inferiority complex) that they never fail do not learn what to do when failure does overtake them. Perhaps one requirement for graduation should be "the student must present some evidence to show that he knows what to do when confronted with failure in some task."

In connection with the work on factoring in the first year of algebra, an interesting doctor's thesis could be based on comparing the two methods: introducing the general case first versus introducing it last. If such an experiment has been conducted the results deserve publicity.

A NEW ARC LAMP

Concentrated arc lamp, whose luminescent source may be as small as 0.003 inch and $\frac{1}{16}$ as bright as the sun, has permanent electrodes sealed into a glass bulb filled with an inert gas. The light-source is a circular spot which forms on a specially prepared zirconium oxide cathode. It is usable for microscope-illumination, ultraviolet radiation, photographic printing and as a lensless projector.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

ONE HUNDRED SIXTY-FIRST MEETING

Milton Academy
Milton, Massachusetts
Saturday, March 2, 1946

MORNING PROGRAM

10:00 Greetings by Mr. Cyril H. Jones, Headmaster, Milton Academy.
10:15 Address: "Post War Radio Telephony," Mr. James W. Kidder, Transmission and Protection Engineer, New England Telephone and Telegraph Company.
11:15 Address: "Gas Turbine Fundamentals," Mr. Dale D. Streid, Aircraft Gas Turbine Division, General Electric Company.
12:30 I uncheon: Forbes Dining Room.

AFTERNOON PROGRAM

1:30 Observatory and various buildings will be open for inspection.
2:00 Address: Presentation Audio-Visual Teaching Aids," Mr. F. M. Carder, Visual Education Service.

In view of the membership list to be included in the projected booklet, the secretary would be glad if each member would send him his correct school and home addresses, so as to avoid errors where changes have occurred.

Officers:

President: John T. Gibbons, Brighton High School, Brighton, Mass.
Vice-President: Albert Thorndike, Milton Academy, Milton, Mass.
Secretary: Carl W. Staples, Chelsea High Scool, Chelsea, Mass.
Treasurer: Albert R. Clish, Belmont High School, Belmont, Mass.

Executive Committee:

George H. Colman, Gloucester High School, Gloucester, Mass.
James J. Cotter, Chelsea High School, Chelsea, Mass.
Edwin Sawin, High School, Cranston, Rhode Island.

BUSINESS MEETING

Clifford H. Theriault, 405 Metcalfe Ave., Westmount, Montreal, Canada was elected to active membership.

It was voted that the officers act as a committee to follow up the matter of surplus electronic equipment and gather information on new developments in the situation.

It was voted that the booklet containing the Constitution, brief history of the Association, and list of members be mimeographed in tentative form and submitted to the members for approval at the next meeting.

A suggestion that branch meetings be held at certain times at different centers in New England in order to increase membership and get more teachers interested in the Association. These meetings were to be attended by delegations from the main body. Nothing definite was decided except that the President of the Association was to attempt to work out a plan to be submitted to the Association at a meeting in the near future.

POST-WAR RADIO TELEPHONY

MR. JAMES W. KIDDER, *Transmission and Protection Engineer, New England Telephone and Telegraph Company*

My subject today is "Post-War Radio Telephony." It will be in the nature of a preview of some of the features we are looking forward to in the further application of radio to the Telephone business. The subject is so comprehensive that my talk must of necessity be a general talk without devoting much time to technical details. Besides not having time for the technical details there are many which have not been decided upon at this time and, therefore, must come later. The features which I shall high spot will undoubtedly provide subjects for a number of technical papers in the next few years.

In this discussion I propose to cover three general topics in the following order: "Radar," "Point-to-Point Radio," and "Mobile Radio." As you all know, Radar was a war activity, but I would like to devote a few minutes to it as an introduction to the Point-to-Point Radio.

The principle of Radar was first discovered in this country in 1922 when two civilian research workers at the Naval Research Laboratory noticed the effect upon the received signals due to waves being reflected from a small wooden steamer on the Potomac. Eight years later these same men discovered they could detect waves reflected from an airplane. As the threat of the airplane as a military weapon was beginning to be realized, the advantages of some method of detecting ships and aircraft was obvious, and work to produce a suitable detector was continued actively by the Navy. In the meantime, the Army had been working on a system of its own, using microwaves. They obtained some reflection from nearby objects but had no device for sending out sufficient power to receive reflections from any distance.

In 1925, the Bell Laboratories developed the Altimeter which used the principle of shooting radio pulses from the plane to the ground and timing the return to the plane. About that same time, this same technique was used to measure the distance between the surface of the earth and the ionosphere, which is the radio reflecting layer near the top of the earth's atmosphere.

The idea of using pulses for radio locating seemed to have been adopted in several countries throughout the world, and much work was done along these lines. The Navy made their first trial installation in 1937 and the Army gave a successful demonstration at Fort Monmouth that same year. Before 1940, Radar activity in this country was confined to a few men in the Army and in the Navy working in two separate groups to obtain a suitable detection device. After 1940, the development was the joint responsibility of the service laboratories, the industrial laboratories and the civilian-government laboratories in this country and England.

A radar system is based upon the characteristic that an electric wave traveling in one medium, such as the atmosphere, and striking a medium

of different composition, such as a ship or plane, some of the wave is reflected back like an echo. The fact that the waves travel in straight lines allows the radar operator to know the direction of the object and from the velocity of the wave and the time between its leaving the origin and the return of the echo, it is possible to measure the distance to the object. The waves travel with the speed of light or about 1000 feet each millionth of a second. Hence, radar technique requires measuring time in microseconds or millionths of a second. As an actual fact, it is possible to measure to 1/30 of this amount which is equivalent to a distance of 10 yards.

A radar system generates high power, high frequency electric waves, projects these from an antenna in a more or less narrow beam, and then picks up any waves which are reflected back and converts them into a pattern on a fluorescent screen. To avoid interference between the transmitted wave and the echo, the former is sent out in pulses. As the reflected power is very small, it is necessary to send out as much power as possible in the transmitted wave.

In general, a Radar set consists of a modulator, a radio frequency oscillator, an antenna with a suitable scanning mechanism, a receiver and an indicator. One of the outstanding war developments of Radar was the "Cavity Magnition" which filled the need of supplying a terrific burst of power at high frequencies, that is greater than the 200 megacycles. One of these magnitions about the size of an ordinary alarm clock could send out 1000 kilowatts of power for a microsecond.

The Radar antenna is made directional by building up an array of small antennae or taking the form of a reflector like a sunbowl. The scanning is accomplished by a mechanical movement of the antenna.

The indicators of the Radar set usually consists of one or more cathode ray tubes. A common method of showing the results is to wire the scope to show the horizontal line proportional to time and have the echo pulse come in vertically. With no objects in range, we see a single horizontal line across the screen. A returning echo gives a V-shaped break in the line. The position of this break with respect to the transmitted pulse is a measure of the distance to the reflecting object. Such a type of scope is known as an "A" scope.

Another form of scope is the PPI tube. In this, the time base starts from the center of the receiver and moves to the circumference as the antenna moves correspondingly. This forms a radial time base which rotates around the antenna. The echo intensifies the brilliance of the time base for an instant instead of causing a break in it. Hence, each echo appears as a bright spot of light at a position corresponding to the range and bearing of the target. Thus, a map-like picture of all reflecting objects appears on the face of the tube. The normal coating of a cathode-ray tube would cause these spots of light to fade away instantly; as a result, no map would be produced. By developing special screens which continue to glow awhile after the spots first appear the entire map was made possible.

The United States was the leader among the United Nations in the research, development and production of Radar. To this leadership the Bell System's extensive research and manufacturing team the Bell Telephone Laboratories and the Western Electric Company made outstanding contributions.

The value of the Radar equipment produced by the Bell System team was about $\frac{1}{3}$ of the total program. Up to July 1 of 1945, the Western had supplied the government with about 56,000 Radar systems of 65 different types. The vast size of the total Radar program is shown by the fact that a total dollar value of $2,700,000,000 worth of Radar equipment was produced in the interval from January 1, 1940 to July 1, 1945. As the Western produced about $\frac{1}{3}$ of the total program, the dollar value of its production was about $900,000,000.

In addition to the Radar equipment, the Western Electric Company produced a vast amount of communication equipment for war purposes. The first of the New England Telephone Company's post-war projects, which I will discuss, is one of these. It is a Point-to-Point radio system.

By its military code, it is known as the ANTRC6, or Army-Navy Transmitter-Receiver C6; I will refer to it as the C6.

Last summer, a trial installation was operated between the New York Telephone Company's building on West Street to Neshanic, N. J., forty miles away. The C6 is unique in that it is the first and only American-Built microwave radio relay communication system to have seen actual used by the armed forces.

The system uses frequencies in the microwave region of nearly five billion or 5,000 megacycles per second. This is a wave length of about 6 centimeters or a little less than $2\frac{1}{2}$ inches. At these frequencies static and most man-made interference are virtually absent. The waves can be concentrated in a sharp beam and require a clear unobstructed straight-line path for their transmission. They do not follow the earth's curvature but shoot off into space. For these reasons, the same frequencies can be used again by other stations. Each system can carry eight high grade telephone channels, any of which can be used for signaling or dialing. If taken out of telephone service, any or all of the channels can carry telegraph, facsimile, or pictures. In military use, one C6 can be transported on a $2\frac{1}{2}$ ton truck and can be placed in operation on a favorable site in about two hours.

As compared with the amplitude modulation used in present broadcasting and the newer frequency modulation which will come into more general use after the war, this C6 uses still another form of modulation known as pulse position modulation. This latest type of modulation not only gives stability and a high quality circuit but also allows us to derive eight channels by what is called the "Time division multi-plexing principle."

In carrying out the pulse modulation method, the speech wave of each message channel being transmitted is sampled 8000 times a second or twice the highest frequency it is desired to transmit from a quality standpoint. Each sampling results in a pulse of high frequency radiation leaving

the antenna. The pulses all have the same duration, about one microsecond, and they all have the same amplitude and frequency. They measure the amplitude of the speech wave from instant to instant by changing their position in time. Between the pulse samplings of one speech channel there will be the pulses representing the other eight channels as they appear in sequence.

A complete group of the channels being transmitted is called the frame and at the beginning of the frame there is a longer so-called "marker" pulse used to synchronize the transmitting and receiving ends of the circuit so that when the different pulses arrive at the receiving end they can be switched or "gated" to the eight different receiving circuits. The electronic gating arrangements are so timed that the particular channel pulse always enters its own circuit. This particular received channel pulse is in effect instantaneously measured and this measurement permits recreating the speech with which the pulse was originally modulated at the sending end.

The antenna system at each terminal of the C6 consists of two parabolic reflectors or "dishpans," five feet in diameter, mounted at the top of a forty-eight foot tower. The tower can be climbed for maintenance and guyed sufficiently so that the antenna will hold the beam pattern to a fraction of a degree in a sixty-mile gale.

The New England Company is planning to install terminals on one of these systems at Hyannis (on Cape Cod) and on Nantucket Island to provide eight additional telephone circuits to Nantucket. These are to supplement the present twelve circuits which are all that can be obtained from the existing submarine cable.

Each terminal will be located on a hill to obtain a line of sight path for the beam. The terminal site will include a small building to house the terminal equipment and to connect with the wire telephone circuits.

Another microwave project is the Boston-New York radio relay system. This is an experiment to determine the relative efficiency and economy of microwave transmission for sound and television programs as well as its use for long distance telephone messages as compared with wire and coaxial cable methods of transmission. The experiment is being conducted by the American Telephone and Telegraph Company through the Bell Telephone Laboratories and is of interest to us in the New England Company because two of the seven relay points and one terminal are in our territory. Work on this project actually began before the war with intensive experiments on microwaves at the Bell Laboratories. The physical work of building the radio relay system involves many factors. The first problem was to make general surveys to find suitable locations for the intermediate relay towers. The stations must be on hilltops in sight of each other, directly or by the aid of towers of moderate height, as the microwaves follow a line of sight path.

The sites finally selected average 27.6 miles apart. The shortest distance between two stations chosen is 11 miles and the longest 35 miles.

The western terminal of the system will be located at the Long Lines Building in New York, which has an elevation of 450 feet above sea level. As these points were selected primarily for elevation and location on the line between New York and Boston, they present a varied assortment of terrain, vegetation and accessibility. As a result, much work is required at each repeater point to construct a road, clear the site, provide power and telephone service and erect a suitable building and antenna.

The eastern terminal of the system will be on top of our Company's Building at Bowdoin Square. Here, the elevation is 225 feet.

The type of modulation to be used in this system has yet to be determined. Several types are now being studied but no decision has been reached as to the type which will be used.

The A. T. & T. Co. is now installing a coaxial cable between New York and the Pacific Coast via a southern route. This cable is already available between New York and Charlotte, N. C. It was used between Philadelphia and New York to transmit the recent Army-Navy football game for broadcasting from NBC's television transmitter on the top of the Empire State Building.

It is anticipated that the microwave link between New York and Boston will serve in place of the coaxial cable in this section.

The Federal Communications Commission has granted the necessary construction permits to begin construction of the New York-Boston microwave system and authorization has also been granted to conduct experimental transmissions on eight 20 mc channels in each of three parts of the radio spectrum near 2,000, 4,000 and 12,000 mc. It is planned to provide initially a regular and a spare transmission in each direction, using different frequencies in adjacent relay sections. The power of the transmitters at the terminals and the relay points will not exceed 10 watts.

Another Post War Radio activity is the so-called "Mobile Service." This is divided into two classes, "Urban" and "Highway."

With the end of the war, it was decided to proceed with the urban service for cities having a population of at least 200,000. This service will be confined to individual cities and their environs, probably within a radius of 20 to 25 miles. It will provide two-way telephone service with motor vehicles or other mobile units such as harbor craft and includes provision for the selective signaling of any unit. This service will also allow one mobile unit to talk with another mobile unit.

One-way signaling (visual or audible or both) service to mobile units might also be provided whereby the driver of the vehicle on receipt of the signal would know that he should call his headquarters from the nearest public telephone. The mobile services will use the frequency modulation method of transmission.

The prospective users of urban mobile service include those business concerns or individuals operating motor vehicles or other mobile units within Metropolitan areas where it is important that headquarters communicate from time to time with the driver or vice versa. Typical prospec-

tive users might include ambulance service, armored car service, burglar and fire alarm companies, doctors, express companies, fruit distributors, public service companies, etc., and might also include boats in adjacent harbors and waterways and railroad switch engines.

The New England Company has received a construction permit from the FCC to build a station in Boston. The transmitting antenna will be located on top of our building at Bowdoin Square. Several receivers will be required which will be located at suitable points in suburban Boston.

The power of the Bowdoin Square transmitter will be 250 watts which will cover the entire urban area. On the other hand, the power of the transmitter on the mobile sets will have a power of 40 watts. The weaker signal from the mobile unit will, therefore, be picked up at the nearest of the several receiver points and transmitted over the wire circuits to the control point at which point it will connect with the regular telephone network. The Bowdoin Square transmitter will use a frequency of 156.53 mc and the mobile receivers will be tuned to this frequency. The mobile units will transmit on 157.43 mc and our fixed receivers will be tuned to this frequency. To permit the attendant at the control point to check the operation of the fixed receivers an auxiliary test transmitter will be provided at Bowdoin Square, operating on the frequency of mobile units. By sending from this test transmitter, the operation of the fixed receivers can be checked by the radioman at the control point.

Calls to and from motor vehicles will be handled by special operators Conversation will travel part of the way by telephone wire and part of the way by radio. If a person in his office calls to talk to the occupant of certain automobile, he first dials or asks for the vehicular operator. He gives her the call number or designation of the vehicle. She sends out a signal on the proper radio channel by dialing the code number assigned to this particular vehicle. An audible or visual signal indicates to the car occupant that he is wanted. He picks up his dashboard telephone and conversation starts. Under his fingers as he holds his telephone handset is a "push to talk" button which permits him to switch from receiving to sending. The operator of a mobile unit can originate calls by picking up his handset and pushing the "talk" button. This calls the vehicular operator in on the line. The subscriber passes her the telephone number he wants and the call goes through.

The present view seems to indicate that the New England Company will have urban vehicular service at Boston, Providence, Worcester and Springfield within the next year or two.

Since deciding to proceed with the urban service it has also been decided to proceed with a trial installation of the highway mobile service between Boston and New York. The highway service is designed to accommodate intercity traffic. Fixed transmitters are planned for Boston, Providence, New London, New Haven, White Plains and New York. The highway service will use frequencies in the 30–40 and the 42–44 mc band. This service will also provide radio service for subscribers in the smaller cities

along the route, which cities will not have sufficient individual traffic to justify an urban station of this own. For example, a doctor in Walpole, Mass., might want a telephone in his car; in which case he would be sold the highway service because Walpole is not large enough to support an urban service. The general arrangement and operation of the highway service will be similar to the urban service in that transmission to the mobile units will come from the fixed transmitters at the six points named. The transmission from the mobile units back to the telephone subscriber will be picked up at fixed receivers scattered at suitable intervals along the route to receive the weaker transmissions from the mobile units at a satisfactory signal strength.

Both the urban and the highway services present many problems which will have to be solved as experience is obtained with the services.

Incidentally, both the urban and the highway services can be extended to mobile units such as tugs and harbor craft. In this way, the proposed Boston-New York service will permit radio service to craft in Boston Harbor, Narragansett Bay and along the Rhode Island and Connecticut shores to New York.

It should be borne in mind that the frequency assignments allocated by the FCC to these mobile services are on an experimental basis and that the final decision is yet to be made as to the method of handling this business. It may be operated by the companies which desire the service such as trucking companies and bus companies, or, a separate company might be formed to sell the service to all those desiring it; or, lastly, it might be handled by an existing common carrier such as the Telephone Company. While it is recognized that the use of these utilities may warrant the excessive use of one or more frequencies, it will be a very rare case where the requirements of any one user will be enough to use capacity of a full radio channel. In view of this and considering the advantages of being able to connect with the extensive wire network of the Telephone System, it would appear as though there are the following reasons why the mobile radio service should be furnished by the Telephone Company.

1. Its development would furnish a coordinated communication system to meet the many needs of customers to secure maximum efficiency of operation and conservation of radio frequencies.
2. The smaller user would be provided for as effectively as the larger user.
3. Common carrier service integrated with the general Telephone System has advantages compared with the isolated basis upon which private radio systems would be employed.
4. The research and development facilities of the Telephone industry would be available to obtain the maximum efficiency in the use of the radio spectrum and to develop the most dependable and comprehensive service.
5. It will avoid a large initial investment by individual users as well as

continuous operating expense and changes required by obsolescence, etc.

In the foregoing you have been given a preview of some of the things which we look forward to in the next few years in the application of radio telephony in our business. Like most previews, it has been quite sketchy. Some time in the future, I hope there will be opportunities for you to get more complete pictures of these various developments and if my preview has aroused your interest sufficiently to cause you to want to see the complete pictures, I am sure I shall consider that the effort required to prepare this preview has been worthwhile.

GAS TURBINE FUNDAMENTALS

Mr. Dale D. Streid of the Aircraft Gas Turbine Division, General Electric Company, River Works, Lynn, Massachusetts gave a very interesting address on the subject of Gas Turbine Fundamentals. As his address had been published in an Engineering periodical previously, it was thought better not to include it herewith, but Mr. Streid has very kindly offered to send a reprint of his address to any of the members who may wish a copy if they will write to him at the above address. Mr. Streid illustrated his talk with a large number of beautifully prepared slides, which attracted much favorable comment from the members present.

PRESENTATION OF AUDIO-VISUAL TEACHING AIDS

F. M. Carder, *Visual Education Service*

I am not a teacher. Actually I come with an apology on my lips, as I appreciate that I am talking to a pioneer group in the use of visual aids. Having been asked to speak on their use, I would like to do so by making a few brief comments of a general nature followed by a period of actual use of visual and audio-visual equipment, at the conclusion of which I would like a period of general discussion when any questions you have can be asked and answered.

Perhaps no one group, by necessity possibly, has done more to utilize the visual means of teaching than your science group. No one today, however, unless exceptionally skilful in presenting his chalk talk, will attempt to compete with the projected picture. The teacher cannot be without the use of some visual or audio-visual aid, either from the point of view of time saved in the preparation and presentation of material, or of the amount of physical effort required thoroughly to cover the subject.

The visual and audio-visual program has developed under several handicaps, possibly the earliest being the use of the old nitrate films which required care in handling, and a licensed operator for projection. I believe this "film-fear" still exists in the minds of some of the older teachers. At least it persisted for some time and was a factor in the tardy development of the teacher use of projectors in the classroom. Unquestionably, another hesitancy in using these tools has been the lack of training. This training has not been done in the teacher training classes except in a very few cases.

It is a condition that calls for a sharing of the experiences of the more fortunate with those who have not received this mechanical knowledge. I may be limited in being unable to train more than one operator and give him a good basic knowledge of the motion picture projector. But if I can train one operator and train him well, he may be able to train one or more, who, in turn, will do likewise, and so on. This would change what is at present a rather impossible utilization situation into a very possible one.

In the past, color was largely the imagination of the artist, and I will have to admit that some of the older color slides were a sorry lot and rather short on imagination. Now, with the advent of color photography, the teacher has a new teaching tool and material that is arresting and pleasing to the eye, as well as stimulating to the senses as no other aids heretofore have been.

In recent years there has come an almost new conception as to the value of visuals in the curriculum. It had been here all the time, but most of us had not recognized it for what it was. We had let Johnnie or Mary acquire a certain amount of it from the movies down the street. They have become so accustomed to the motion picture that it behooves teachers to present their material in this medium of ready acceptance, and to take advantage of this method of learning.

Films for teaching must, of necessity, be brief, but not so condensed as to sacrifice clearness, and, of course, should be in color whenever practicable. Sound films should be used in preference to silent, but no film by itself, but in conjunction with the text-book. One should make previews of all new subject material, and reviews to make it stick.

One should not expect or let the film do the teaching. One will find that most films require one's best teaching efforts, "as a better tool needs a better workman."

The use of opaque projection necessitates darkening of the room where a projection room is not available, but otherwise it is an excellent teaching tool, and a means of projecting material compiled by the teacher or student, also obviating the passing around of specimen matter.

The use of still pictures lends itself to the greatest amount of flexibility. These may be the older type $3\frac{1}{4}\times 4$ glass slides, the 35 mm film strip, or the $2''\times 2''$ color slides. This method is also adaptable for use under circumstances where it is impossible to use other means of projection.

Several features go to make up the desirability of using the film strip or the $2''\times 2''$ slide, and tend to make it an ideal teaching equipment. Most important may be the fact that it uses the step plan of teaching, and second it saves time, as a good film strip will embody all the black board work that a good teacher dreams about, but finds physically impossible to accomplish. Further, and most important in my way of thinking, there is presented a picture kindly to the eyes, and still much more vivid to the imagination, and yet one which is seen alike by all the class.

It can also be turned back to a previous frame to clear up any misunderstanding or questionable point. The up-grading is done with minimum

effort and loss of time. The projectors are quickly and easily operated. Any pupil can be an operator without previous training and the teacher remains in his proper relation to the class.

If a sufficiently high wattage projector is used very little preparation is needed in making the room ready, or in having the screen protected from direct light, as fairly good results can be obtained in rooms with southern exposure.

I have taken up the more common teaching aids. Most schools have at least one radio. Effectively to use this radio, a recorder should be part of the equipment. If it is a disc type recorder, it should have a speed of 78.26 and 33⅓ and should be also a combination playback unit.

Wire and tape recorders are around the corner, but I would rather not pass an opinion at this time, as there are tendencies toward torsion in the wire which render them somewhat unsatisfactory. With your sound projector or separate P.A. system you may use a microphone or microphones, and the single speed or combination transcription and record player. A central sound system is possible for any size school. For the larger school a separate P. A. control is advisable for hall and stairway traffic.

There are a few simple rules that are easy to keep in mind in the use and adaptation of screens and screen fabrics, which I believe you all know. In conclusion, I would like to urge a sharing of the mechanical knowledge of your group and the passing on of all the knowledge that you can. Should you have individual problems, pass them on to your visual aids specialist. In so far as is humanly possible, I will make the offer of my time if I can help out in any situation.

Mr. Carder with the assistance of Mr. M. Keith Ledyard of the Jam Handy Corporation, Detroit, showed several types of projectors, a film slide on transmitted pressure, which was very good; and a moving picture on Electricity, which, while good in the general idea, had some errors in it, and was a little unsound pedagogically in that it confused the differences between magnetism and electricity.

SUPERIOR SCIENCE WON NAVAL VICTORY OVER UNDERSEA RAIDERS

Scientific superiority that developed sonar for accurately locating submerged enemy submarines was credited with bringing victory against Nazi U-boats in World War II as the Navy today revealed the story of the battle against undersea raiders.

Sonar, improved during the war by cooperative work in Allied laboratories, was credited for the sinking of a majority of the 996 enemy submarines sent to the bottom during hostilities. The Navy said that 70% of the undersea "kills" were made by British ships and 30% by U. S. vessels.

Termed the only effective method of detecting completely submerged submarines, World War II sonar is a highly developed system for echoing sound waves sent out under the ocean's surface. Submarines were detected by the echoed sound, and the development of echo-ranging permitted ships accurately to locate and track down submerged U-boats.

PROBLEM DEPARTMENT

Conducted by G. H. Jamison
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

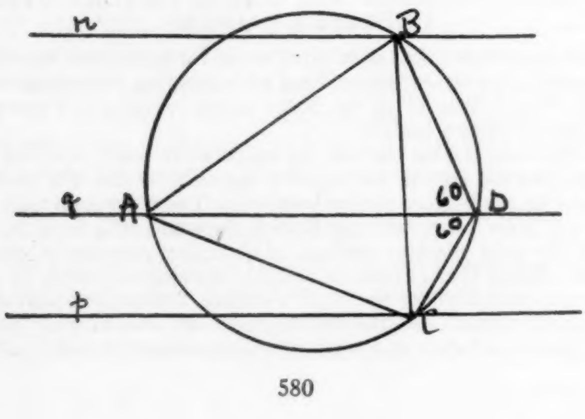
1966. *Paul Mont-Cambell, N. Mex. Military Institute.*

1963. *Louis Moskowitz, Brooklyn, N. Y.*

1964, 5. *Hugo Brandt, Chicago.*

1969. *Proposed by Brother Felix John, Philadelphia, Pa.*

Given three parallels, p, q, r, with p and q, a units apart, and q and r, b units apart. Construct an equilateral triangle with one vertex on each parallel.



Solution by D. F. Wallace, St. Paul, Minn.

From any point, as D, on the middle parallel, q, draw DB and DC meeting p at B and r at C respectively, DB and DC each making an angle of 60° with q so that $\angle BDC = 120°$. Draw BC.

Draw the circumcircle of triangle BDC intersecting q again at A. Draw AB and AC.

ABC is the triangle required.

Proof: Since $\angle BDC = 120°$, $\angle BAC = 60°$.

$\angle ACB = \angle ADB$, these angles being measured by $\frac{1}{2}$ the same arc AB.

$\angle BDA = 60°$ by construction. $\therefore$ $\angle ACB = 60°$.

$\therefore$ $\angle ABC = 60°$.

$\therefore$ ABC is an equilateral triangle with one vertex on each parallel.

Reference: *Altshiller-Court College Geometry*, p. 47.

Solutions were also offered by C. W. Trigg, Los Angeles City College; Francis L. Miksa, Aurora, Ill.; Hazel S. Wilson, Annapolis, Md.; Isadore Gosz, West DePere, Wis.; Hugo Brandt, Chicago; Martin Pearl, Brooklyn, N. Y.; M. Kirk, Media, Pa.; Helen M. Scott, Baltimore, Md.; E. Robinson, Farmer City, Ill.; Felix John, Philadelphia, Pa.; B. C. Eastham, East, Hartford, Conn.; V. C. Bailey, Delaware, Ohio.

1970. *Proposed by Grace Marsh, Mexico City, D. F.*

In any triangle which has $a+b=2c$, show that $a\cos B - b\cos A = 2(a-b)$.

Solution by Helen M. Scott, Baltimore, Md.

$$a+b=2c, \tag{1}$$

$$\cos B=\frac{a^2+c^2-b^2}{2ac}, \tag{2}$$

$$\cos A=\frac{b^2+c^2-a^2}{2bc}, \tag{3}$$

$$a\cos B-b\cos A=\frac{a^2+c^2-b^2-b^2-c^2+a^2}{2c}, \tag{4}$$

$$a\cos B-b\cos A=\frac{2(a^2-b^2)}{a+b}, \tag{5}$$

$$a\cos B-b\cos A=2(a-b). \tag{6}$$

Solutions were also offered by Louis Moskowitz, Brooklyn, N. Y.; Martin Pearl, Brooklyn, N. Y.; Julius S. Miller, Los Angeles, Calif.; Nicholas Logothets, Newport, R. I.; Felix John, Philadelphia, Pa.; Willard E. Wells, Los Angeles, Calif.; Hazel S. Wilson, Annapolis, Md.; A. W. Gordon, Chilton, Wis.; M. Kirk, Media, Pa.; Francis L. Miksa, Aurora, Ill.; E. Robinson, Farmer City, Ill.; V. C. Bailey, Delaware, Ohio.

1971. *Proposed by Sam Morgan, Jr., Pasadena, California.*

If C_n and S_n are used to denote the sums of the first n terms of the series,

$$(1/2+\cos\theta+\cos 2\theta+\cdots), \qquad (\sin\theta+\sin 2\theta+\cdots).$$

Find

$$\text{limit } (C_1+C_2+\cdots+C_n) \quad \text{and} \quad \text{limit } (S_1+S_2+\cdots+S_n) \quad \text{as } n \doteq \infty$$

as $n \doteq \infty$ provided there exist limits.

Solution by Francis L. Miksa, Aurora, Ill.

We shall need four general formulas, for the sums A_1, A_2, A_3, and A_4 of the following four trigonometric series. (For reference see H. B. Dwight, *Tables of Integrals and other Mathematical Data.* Pp. 66 to 79).

$$A_1=\cos(a)+\cos(a+d)+\cdots\cos[a+(n-1)d]$$

$$=\frac{\sin[a+(2n-1)d/2]-\sin[a-d/2]}{2\sin(d/2)} \tag{1}$$

(alternative form)

$$A_1=\frac{\sin(nd/2)\cos[a+(n-1)d/2]}{\sin(d/2)}.$$

When $d=a$ then the series A_1 become

$$A_2=\cos(a)+\cos(2a)+\cdots\cos(na)$$

$$=\frac{\sin[(2n+1)a/2]-\sin(a/2)}{2\sin(a/2)}=\frac{\sin[(2n+1)a/2]}{2\sin(a/2)}-\frac{1}{2} \tag{2}$$

(alternative form)

$$A_2=\frac{\sin(na/2)\cos[(n+1)a/2]}{\sin(a/2)}.$$

$$A_3=\sin(a)+\sin(a+d)+\cdots\sin[a+(n-1)d]$$

$$=\frac{\cos(a-d/2)-\cos[a+(2n-1)d/2]}{2\sin(d/2)} \tag{3}$$

(alternative form)

$$A_3=\frac{\sin[a+(n-1)d/2]\sin(nd/2)}{\sin(d/2)}.$$

When $d=a$ then the series A_3 become

$$A_4=\sin(a)+\sin(2a)+\cdots\sin(na)$$

$$=\frac{\cos(a/2)-\cos[(2n+1)a/2]}{2\sin(a/2)} \tag{4}$$

(alternative form)

$$A_4=\frac{\sin[(n+1)a/2]\sin(na/2)}{\sin(a/2)}$$

Now the successive values of C_i's are:

$$\begin{aligned} C_1&=1/2+0,\\ C_2&=1/2+\cos\theta,\\ C_3&=1/2+\cos\theta+\cos(2\theta),\\ &\cdots\cdots\cdots\cdots\\ C_n&=1/2+\cos\theta+\cos(2\theta)+\cdots\cos(n=1)\theta. \end{aligned} \tag{5}$$

Each successive C_i has a constant term $1/2$ and sum of cosine series $A_2=\cos(a)+\cos(2a)+\cdots$ etc. where $a=\theta$. $\therefore$ Use formula (2) to evaluate each successive C_i.

NOTE: For C_1, $n=0$ in formula (2).

For C_2, $n=1$ in formula (2).

Thus:

$$C_1=1/2+\frac{\sin\,[2(0)+1](\theta/2)}{2\sin(\theta/2)}-1/2=\frac{\sin(\theta/2)}{2\sin(\theta/2)}$$

$$C_2=1/2+\frac{\sin\,[(2+1)\theta/2]}{2\sin(\theta/2)}-1/2=\frac{\sin(\theta/2+\theta)}{2\sin(\theta/2)}$$

$$C_3=1/2+\frac{\sin(5\theta/2)}{2\sin(\theta/2}-1/2=\frac{\sin(\theta/2+2\theta)}{2\sin(\theta/2)} \tag{6}$$

$$\cdots\cdots\cdots\cdots$$

$$C_n=1/2+\frac{\sin\,[2(n-1)+1](\theta/2)}{2\sin(\theta/2)}-1/2=\frac{\sin\,[\theta/2+(n-1)\theta}{2\sin(\theta/2)}.$$

The constant term 1/2 cancels in each term. Summing all the C_i's we get

$$\sum_1^n C=\frac{\sin(\theta/2)+\sin(\theta/2+\theta)+\sin(\theta/2+2\theta)+\cdots+\sin\,[\theta/2+(n-1)\theta]}{2\sin(\theta/2)}. \tag{6.1}$$

But the numerator of the above sum contains exactly the series A_3 with $a=\theta/2$ and $d=\theta$. Hence applying formula (3), the alternative form, we get.

$$\sum_1^n C_i=\frac{\sin(n\theta/2)\sin\,[\theta/2+(n-1)\theta/2]}{2\sin^2(\theta/2)}=\frac{\sin^2(n\theta/2)}{2\sin^2(\theta/2)}. \tag{7}$$

Now using the relation $\sin^2(X/2)=(1/2)(1-\cos X)$ we get

$$1/n\sum_1^n C=\frac{(1-\cos n\theta)}{2n(1-\cos\theta)}=(1/n)C_i \tag{8}$$

The following limits exist as $n\to\alpha$

θ	$1/nC_i$
0	α
90	0
180	0
270	0
560	α

(9)

Coming now to the sine terms we have for successive S_i's.

$$S_1=\sin\theta,$$
$$S_2=\sin\theta+\sin(2\theta),$$
$$S_3=\sin\theta+\sin(2\theta)+\sin(3\theta), \tag{10}$$
$$\cdots\cdots\cdots\cdots$$
$$S_n=\sin\theta+\sin(2\theta)+\cdots+\sin(n\theta)$$

Each successive S_i in the above is the series A_4, where $a=\theta$. Using formula (4) we evaluate each S_i.

$$S_1=\frac{\cos(\theta/2)-\cos(3\theta/2)}{2\sin(\theta/2)}=1/2\cot(\theta/2)-\frac{\cos(3\theta/2)}{2\sin(\theta/2)}$$

$$S_2=\frac{\cos(\theta/2)-\cos(5\theta/2)}{2\sin(\theta/2)}=1/2\cot(\theta/2)-\frac{\cos(3\theta/2+\theta)}{2\sin(\theta/2)}$$

$$\cdots\cdots\cdots\cdots \tag{11}$$

$$S_n=\frac{\cos(\theta/2)-\cos[(2n+1)\theta/2]}{2\sin(\theta/2)}=1/2\cot(\theta/2)-\frac{\cos[3\theta/2+(n-1)\theta]}{2\sin(\theta/2)}.$$

Summing all S_i's we get:

$$\sum S_i=(n/2\cot(\theta/2)-\frac{\cos(3\theta/2)+\cos(3\theta/2+\theta)+\cdots+\cos[3\theta/2+(n-1)\theta]}{2\sin(\theta/2)}. \quad (12)$$

The numerator in the fraction above is again the series A_1 where $a=3\theta/2$ and $d=\theta$. Hence using formula (1), alternative form we get:

$$1/n\sum_1^n S_1=(1/2)\cos(\theta/2)-\frac{\sin(n\theta/2)\cos[(n+2)\theta/2]}{2n\sin^2(\theta/2)}. \quad (13)$$

Which after some transformations reduces to

$$1/n\sum S_1=\frac{(n+1)\sin\theta-\sin(n+1)\theta}{2n(1-\cos\theta)}=S_t\cdot(1/n). \quad (14)$$

The following limits obtain as $n\to\alpha$

θ	$(1/n)S_t$
0	0
90	1/2
180	0
270	$-1/2$
360	0
$0<\theta<90$	$\frac{\sin(\theta)}{2(1-\cos\theta)}$
$90<\theta<180$	$\frac{\sin\theta}{2(1-\cos\theta)}$
$180<\theta<270$	$\frac{-\sin\theta}{2(1-\cos\theta)}$
$270<\theta<360$	$\frac{-\sin\theta}{2(1-\cos\theta)}$

(15)

1972. *Proposed by Stanley Fifer, Hyattsville, Md.*

Any odd number of integers can always be chosen so that their sum is a perfect square.

Solution by Mary Holden, Jennings, Mo.

If a is any odd number then a terms can always be chosen whose sum is a perfect square. Thus:

$$\left(a-\frac{a-1}{2}\right)\cdots+(a-1)+a+(a+1)+(a+2)+\cdots\left(a+\frac{a-1}{a}\right)=a(a)=a^2.$$

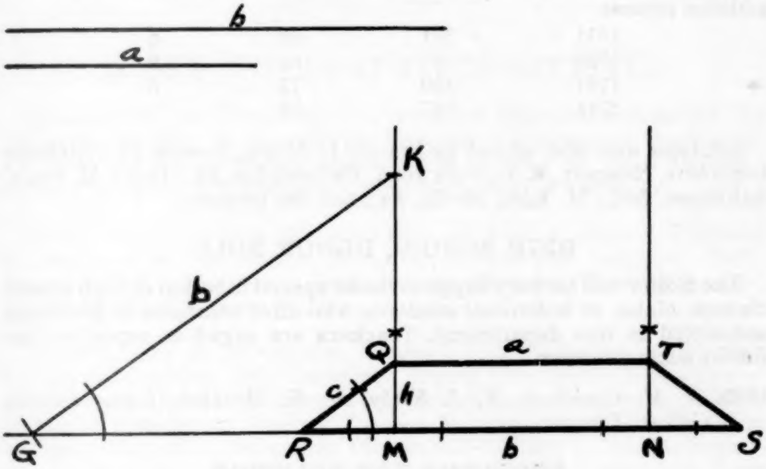
D. A. Wallace, St. Paul, Minn. offers the interesting comment and solution given below:

The problem might have read: Any number of integers (omitting "odd") can always be chosen so that their sum is a perfect square. Take x integers, where x is even or odd, and if their sum, y, is not a perfect square subtract y from any integer z, which is a perfect square. Add $z-y$ to any one of the x integers. Then the sum of the x integers, when one of them is in-

creased by adding $z-y$ to it, will be z, a perfect square. Or separate $z-y$ into any number not greater than x parts and add each of the parts to one of the x integers. Then the sum of the x integers when so increased will be z.

1973. *Proposed by D. A. Wallace, St. Paul, Minn.*

Construct an isosceles trapezoid in which the altitude is the fourth proportional to the two bases and one of the equal sides.



Solution by A. W. Gordon, Chilton, Wis.

(1) Bases a and b may be of any length.
(2) Lay off $RS=b$.
(3) On RS lay off $RM=\frac{1}{2}(b-a)$.
(4) At M construct $MK\perp RS$.
(5) Make $MK=a$.
(6) Lay off $KG=b$.
(7) Construct $\angle MRQ=\angle G$.
(8) Then $\triangle GKM \backsim \triangle RMQ$.
(9) $\therefore\ b:a=c:h$.

Solutions were also offered by Helen M. Scott, Baltimore, Md.; M. Kirk, Media, Pa.; Martin Pearl, Brooklyn, N. Y.; and the proposer.

1974. *Proposed by D. A. Wallan, St. Paul, Minn.*

Find a short way for finding the cubes of consecutive integers by addition alone.

Solution by C. W. Trigg, Los Angeles City College

We note that

$$(n+1)^3=n^3+[3n(n-1)+1]+6(n-1)+6. \qquad (1)$$

Also that

$$6+6(n-1)=6n \qquad (2)$$

$$6n+[3n(n-1)+1]=3(n+1)n+1 \qquad (3)$$

and

$$[3(n+1)n+1]+n^3=(n+1)^3. \qquad (4)$$

To compute the cubes of consecutive integers, start with any n, say 11. Put down the values of the four terms of the right-hand member of (1) in order. Place another 6 in the right-hand column, and generate the other terms in the row by applying equations (2), (3) and (4) in order. For example, $6+60=66$, $66+331=397$, and $397+1331=1728=12^3$. The process may then be continued indefinitely by repeated application of the addition process.

1331	331	60	6
1728	397	66	6
2197	469	72	6
2744	547	78	6

Solutions were also offered by Francis L. Miksa, Aurora, Ill.; Nicholas Logothets, Newport, R. I.; Felix John, Philadelphia, Pa.; Helen M. Scott, Baltimore, Md.; M. Kirk, Media, Pa.; and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

1970. *R. M. Couinlock, N. J. Kirby, M. K. Macklem, Upper Canada College, Toronto.*

PROBLEMS FOR SOLUTION

1987. *Proposed by Howard D. Grossman.*

Find the sum to infinity of

$$1/2+1/3+1/4-1/5-1/6-1/7+1/8+1/9+1/10-\cdots$$

1988. *Proposed by Ollie Raeder, Fayette, N. Y.*

In Quadrilateral $ABCD$, if $AB=11$, $BC=13$, $CD=15$, $DA=7$ and $AC=20$, find the length BD.

1989. *Proposed by Walter R. Warne, Columbia, Mo.*

Solve the system:

$$\frac{(x+y+1)^2}{x^2+y^2+1}=\frac{18}{7}$$

$$\frac{(x+y+1)^2}{xy}=36.$$

1990. *Proposed by Gladys Platner, Oneonta, N. Y.*

In triangle ABC, if D is located on BC, so that $BD=1/3BC$, and if E is on AB so that $BE=3/4BA$, what part of triangle ABC is BED?

1991. *Proposed by Hugo Brandt, Chicago, Ill.*

Find the volume of the solid enclosed by the planes

$$z=2x, \quad z=3y, \quad 3x+3y=4.5z \quad \text{and} \quad 6x+6y+11z=120.$$

1992. ***Proposed by Harold Grossman, New York.***

Solve the system:

$$x^2-y=2$$
$$y^2-z=2$$
$$z^2-w=2$$
$$w^2-x=2$$

BOOKS AND PAMPHLETS RECEIVED

DIAGNOSTIC AND REMEDIAL TEACHING IN SECONDARY SCHOOLS, by Glenn Myers Blair, Ph.D., Assistant Professor of Educational Psychology, University of Illinois. Cloth. Pages xv+422. 13×20.5 cm. 1946. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.25.

ELEMENTARY APPLIED AERODYNAMICS, by Paul E. Hemke, Professor of Aeronautical Engineering, Rensselaer Polytechnic Institute. Cloth. Pages viii+231. 15×23 mc. 1946. Prentice-Hall, Inc. 70 Fifth Avenue, New York 11, N. Y. Price $3.25.

MAKING SURE OF ARITHMETIC, Grades 5, 7, 8, by Robert Lee Morton, College of Education. Ohio University, Athens, Ohio; Merle Gray, Director of Elementary Education, Hammond Public Schools, Hammond, Indiana; Elizabeth Springstun, Training Teacher, Intermediate Grades, National College of Education, Evanston, Illinois; and William L. Schaaf, Department of Education, Brooklyn College, Brooklyn, New York. Cloth. Each Book has iii+348 pages, 14×21 cm. 1946. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price each $1.04.

SCIENCE IN A CHANGING WORLD, by Emmett James Cable, Ph.D., Head of the Science Department; Rlobert Ward Getchell, Ph.D., Professor of Chemistry; and William Henry Kadesch, Ph.D., Professor of Physics, Iowa State Teachers College. Revised Edition. Cloth. Pages xvii+622. 14.5×23 cm. 1946. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.00.

DESCRIPTIVE GEOMETRY, by Earle F. Watts, S. B., Associate Professor of Drawing and Descriptive Geometry, Massachusetts Institute of Technology, and John T. Rule, S. B., Associate Professor of Drawing and Descriptive Geometry, Chairman, Section of Graphics, Massachusetts Institute of Technology. Cloth. Pages viii+3p1. 14.5×23 cm. 1946. Prentice-Hall, Inc., 70 Fifth Avenue, New York, 11 N. Y. Price $3.00.

COLLEGE PHYSICS, by William T. McNiff, Assistant Professor of Physics, Fordham University Press, 441 E. Fordham Road, New York 58, N. Y. Price $4.00.

VOLCANOES NEW AND OLD, by Satis N. Coleman, Author of *Creative Music in the Home*. Cloth. Pages vii+222. 15×23.5 cm. 1946. The John Day Company, 2 West 45th Street, New York 19. N. Y. Price $3.75.

ELECTRICITY: SOME DANGERS AND BENEFITS, by William T. McNiff, M.A., Department of Physics, Fordham University. Paper. 31 pages. 14×

23 cm. Fordham University Press, 441 E. Fordham Road, New York 58, N. Y.

SWORDS INTO PLOWSHARES. WHAT CIVILIAN EDUCATION CAN LEARN FROM THE TRAINING PROGRAM OF THE ARMED FORCES, by Raleigh Schorling, Professor of Education, University of Michigan, and others. Paper. Pages xx+44. 21.5×28 cm. 1946. Eugene B. Elliott, Superintendent of Public Instruction, Lansing, Michigan.

ONE WORLD OR NONE. A Report to the Public on the Full Meaning of the Atomic Bomb, Edited by Dexter Masters, Editor of *Science Illustrated*, and Katharine Way of the Metallurgical Laboratory, University of Chicago. Paper. Pages x+79. 21×28 cm. 1946. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $1.00.

JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES. Volume I, Number 1. January 1946. 182 pages. 16.5×25.5 cm. Published Quarterly by Henry Schuman, 20 East 70th Street, New York 21, N. Y. Subscription rate is $7.50 in the U. S., Canada and Latin America; $8.50 elsewhere. Single copies $2.50.

BIOLOGICAL ABSTRACTS, Section H—Human Biology. Volume 20, Number 1. January, 1946. 36 pages. 20×26.5 cm. Biological Abstracts, University of Pennsylvania, Philadelphia 4, Pa. Price $6.00 a year. (Foreign, $6.50.)

BOOK REVIEWS

INDUSTRIAL ALGEBRA AND TRIGONOMETRY WITH GEOMETRICAL APPLICATIONS, by John H. Wolfe, Sc.D., William F. Mueller, A.B. and Seibert D. Mullikin, B.S. Cloth 389 pages. 13.5×21 cm. 1945. McGraw-Hill Book Company, Inc. New York, New York. $2.20.

This book, written by men who have had many years of experience in the Ford Training Division of the Ford Motor Company, meets a need in industrial mathematics in that it presents intermediate algebra and trigonometry with geometrical applications to practical problems which were first confronted by laymen and engineers and finally submitted to Ford Training Division for instructional purposes. All the material has been used in the Ford School with notable success.

Industrial algebra and trigonometry with geometrical applications is a book which presents in a much more complete form than the usual industrial book the topics of intermediate algebra and tirgonometry. The algebra section includes such topics as Fundamental Operations, Factoring, Fractions, Equations, Exponents and Radicals, Simultaneous Linear Equations Quadratic Equations, Systems of Equations, Radical Equations, and Higher Degree Equations. The topics of trigonometry are Trigonometric Functions (Acute Angles), Functions of Any Angle, Oblique Triangles, Analytic Trigonometry (Functions of Two Angles), Radian (Circular) Measure, and Compound Angles. The subject of logarithms is presented in the usual manner and includes in addition to computation by logarithms, changing the base of logarithms, logarithms of trigonometric functions and solution of oblique triangles by logarithms. Tables of natural functions, five place tables of common logarithms, and logarithms of trigonometric functions are printed as part of the book.

There is an abundance of the problem material presented in a very attractive manner with mechanical drawings and sketches and in some of the examples, construction lines which suggest the steps in the solution. The pupil is given an opportunity to meet the problem in as near a practical situation as is possible in a textbook. This should motivate the work since the pupil can see and use the application to the practical problem while learning the fundamentals of the mathematical operation.

Those high schools that have string Vocational Departments and are teaching mathematics as a related subject, could well afford to examine this book.

DOYLE T. FRENCH
Elkhart High School, Elkhart, Ind.

THE PRINCIPLES OF HEREDITY, by Laurence H. Snyder, *Professor of Zoology and Chairman of the Department*, The Ohio State University. Third Edition, Cloth. Pages xvi+450, 15×23 cm. 1946. D. C. Heath and Company, Boston. Price $3.75.

The author has made a number of changes in the third edition of this excellent textbook. The chapters on multiple factors, statistical treatment, and selection and inbreeding have been regrouped to form a unit on quantitative inheritance. The chapter on statistical treatment has been rewritten, as have also those dealing with human heredity and eugenics. In several places in the book improved diagrams have been substituted for the old ones; a few new figures have been added and several figures have been deleted. There is a new discussion of the Rh factor in man and the genetics of *Neurospora*. In size and content the book remains much the same as before: the number of pages is two less and the figures nine fewer than in the second edition.

Physically the book shows a trait common to the products of many publishers during the last few years—one which it is hoped is only a temporary expedient: thin translucent paper which permits the type to show through the sheet and does not do full justice to the halftones. As a partial compensation there is a reduction in the weight and volume of the book of about thirty per cent.

The text seems unusually free of typographical errors. The index appears to be complete although some of the entries with a long list of page numbers would be more accessible if subdivided.

E. C. COLIN
Chicago Teachers College

ELEMENTS OF CALCULUS, by William Anthony Granville, Ph.D., LL.D. *Formerly President of Gettysburg College*, Percey F. Smith, Ph.D., and William Raymond Longley, Ph.D., *Professors of Mathematics, Yale University*. Cloth Pages xi+549. 15×23 cm. 1946. Ginn and Company, Statler Building, Boston, Mass. Price $3.75.

An assignment to review a new edition of Granville's *Calculus* is similar to an assignment to review a new edition of the Bible. To generations of sophomores this book has been the word of authority.

The present revision consists chiefly of a rearrangement of material, dictated by a desire to introduce both the differential and the integral calculus as early in the curse as possible. The technique of integrating algebraic functions immediately follows the development of formulas for their differentiation, and applications of both differentiation and integration precede the introduction of the transcendental functions. The early presentation of integration should be of distinct advantage to students who

are taking courses in physics and engineering at the same time that they are studying the calculus.

Few alterations have been made in the text, but many new problems have been introduced. The authors' hope that teachers will find the revision an improvement over earlier editions seems justified by past experience. Teachers and students have been finding the book good since 1904.

HARRY S. POLLARD
Miami University, Oxford, Ohio

ANALYTICAL GEOMETRY, by Francis D. Murnaghan, Ph. D. (Johns Hopkins), D. Sc. (Nat. Univ. Ireland), *Professor of Applied Mathematics, The Johns Hopkins University*. Cloth. Pages viii+402. 15×23 cm. 1946. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $3.25.

Professor Murnaghan's book presents a novel treatment of analytic geometry. Instead of the customary approach, he introduces vectors in the first chapter and makes systematic use of vectors and matrices throughout the text. The aim of this approach is to bridge the gap between mathematics and studies of physics and engineering, as well as to present a point of view which can be carried over into more advanced courses in mathematics.

The author suggests that the material of the first nine chapters might be taught in one term of the freshman year. These chapters include points and vectors in a plane and in space, vector products and the equations of lines, determinants and matrices, the circle and sphere, and the conic sections. The last three chapters, which are suggested as a part of a course for the sophomore year, include second degree surfaces, and the general equation of the second degree in two and three variables.

The author makes a plea in his introduction for the offering of more advanced mathematics in the high schools, so that students of physics and engineering may not be handicapped by the fact that their calculus must be postponed until the sophomore year. This reviewer would agree, provided the inclusion of more material in the high-school course was not accomplished by sacrificing a thorough grounding in elementary mathematics—algebra, geometry, and trigonometry.

Teaching this text should be an interesting experience.

HARRY S. POLLARD

PLANE AND SPHERICAL TRIGONOMETRY, by Harvey Alexander Simmons. Ph.D., *Associate Professor of Mathematics, Northwestern University*, Second Edition. Cloth. Pages xi+387. 14×21.5 cm. 1945. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $2.25.

This text has several unique features which should appeal to the teacher of trigonometry. The author first defines the general trigonometric functions, instead of first defining those of the acute angle and later being under the necessity of generalizing his particular definitions. This method seems to the writer to be of advantage since the student is familiar with the rectangular system of coordinates.

His discussion of significant figures should instill in the student a greater appreciation of the accuracy to be expected in a given operation. The problems throughout the text are well chosen, with emphasis on the practical applications. The subject of trigonometric equations which is often fraught with very great difficulties for the student is discussed at some length and in rather great generality.

The spherical trigonometry is preceded by selected topics from solid

geometry, a very timely presentation in view of the fact that many students have not had a course in solid geometry. The few lessons devoted to this subject should be well spent inasmuch as the student will be given a true appreciation of the principles of solid geometry which would otherwise be vague to him. The usual methods of solution of the spherical triangle, including the haversine formulas, are given. The applications to the different types of sailing and to the astronomical triangle should prove of great value.

The principle of the slide rule is explained in an appendix and problems are given in sufficient number to enable the student to use it with facility. Another appendix is devoted to complex numbers, with a discussion of DeMoivre's theorem and the expression of the trigonometric and exponential functions as infinite series. Problems are sufficiently abundant and general to permit the instructor a wide choice of material to fit the needs of classes extending over varying lengths of time and with varying degrees of previous preparation.

It should prove a very satisfactory text.

W. E. Anderson

Optical Instruments, by Earle B. Brown, with a foreword by James G. Baker, Ph. D., *Harvard College Observatory*. Cloth. Pages xii+567. 15×22 cm. 1945. Chemical Publishing Co. Inc. Brooklyn, N. Y. Price $10.00.

During the war the armed forces made great use of optical instruments and the author, attached to the Santa Anita Ordnance School has written this book to describe them. The first sixteen chapters in part I explore the principles of Geometrical Optics, covering reflection, refraction, critical angle, prisms, lenses, the human eye, erecting systems, eyepieces, and reticles

Part II describes in ten chapters the operation and theory of the telescope, camera, microscope, field glasses and binoculars, projector, spectroscope, theodolite, range finder, and various other military instruments.

The construction and maintenance of optical instruments occupies four chapters in part III. The grinding and polishing of lenses and prisms, their testing and adjustment is described.

Part IV discusses design of optical systems, the manufacture of optical glass and some notes on physical optics.

The volume concludes with an appendix containing mathematical proofs and a glossary of optical terms.

For the most part the volume is written in an interesting and informative way. However a few errors occur in the text. The author misstates the principle of Fermat on page 8 as referring only to an optical path containing the minimum number of waves between any two given points, whereas the principle admits of both maximum and minimum values. The author, however, adds that "It is now known that sometimes the path is not a minimum but a maximum, but it is always one or the other." On page 43 total reflection is explained as occurring when the sine of the limiting angle of incidence "is greater than 1." Of course the author knows that the sine of an angle cannot be greater than one.

The diagrams in the text are excellent but the pen-and-ink drawings are poorly drawn and detract from the appearance of the book which is otherwise good. The paper is glossy.

Since no examples or problems are given, the book is not intended as a text but as a reference work.

E. N, Code,
Chicago, Illinois

WORKBOOK WITH LABORATORY EXERCISES FOR USE WITH PHYSICS, by Elmer E. Burns, *Teacher of Physics (Emeritus), Austin High School, Chicago;* Frank L. Verwiebe, *Associate Professor of Physics, Hamilton College, Research Associate Army Institute, Formerly Associate Professor of Physics, Eastern Illinois State Teachers College;* and Herbert C. Hazel, *Major, U. S. Marine Corps, Formerly Head of Science Department, Bloomington, Indiana High School, Assistant Professor of Physics, Indiana University.* Paper. Pages iv+392. 17.5×27.5 cm. 1945. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y.

Most physics teachers of experience agree that it is difficult to judge a workbook and laboratory manual without having actually used the book in the classroom and laboratory situation. With the understanding that this teacher has not used the book I will comment briefly on it. *The Workbook with Laboratory Exercises* by Elmer E. Burns, Frank L. Verwiebe and Herbert C. Hazel is published by D. Van Nostrand Co. It "is arranged to parallel the text *Physics a Basic Science* being organized in corresponding units."

It is the experience of this reviewer that no workbook, no matter how excellent, can be entirely satisfactory to both student and teacher when used with a textbook other than the one it was designed to accompany. The authors of this workbook have set up the same high standard for their workbook and lab manual that they have in their textbook.

Quoting from the preface to the teacher: "A large number and variety of exercises are included. Exercises A and B consist of completion tests, problems, discussion questions, graphical work, etc. suited to the nature of the material in the units. The 'What Would You Do' questions are designed to stimulate the student in applying his knowledge to new situations, so that mere memory of factual material will not suffice. Multiple choice tests have been added to provide simple and rapid means of testing. The wide range of exercises and questions will allow selection for the needs of the class or of the individual student." An examination of the book justifies these statements. The "What Would You Do" thought type of question provides a welcome and much needed change from the purely objective type of workbook material, although the old difficulty of judging or grading the students answers will again present itself.

When a new laboratory manual is adopted there is always the equipment problem. In this manual, traditional experiments are included and a few new and novel ones as well. The new experiments have hints as to the construction of the equipment and therefore it should not be difficult to adapt this manual to the usual supply of equipment.

The last section of the manual has a fine section on electronics which shows an unmistakable trend to add this important topic to the physics course.

The Unit organization follows the traditional pattern but Unit 2 on Molecules, Unit 21 on Electric Circuits and Unit 25 on Electronics show by their titles a slight departure from some author's arrangements.

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AIR SPEED INDICATOR

True air-speed indicator basically consists of three separate units, air-speed indicator, altimeter and air thermometer, combined in one interacting assembly. The pilot merely reads the true speed on a dial, all computations being made automatically by the instrument.